INTERNATIONAL
COMPARISONS
IN EDUCATION

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International Comparisons in Education — Curriculum, Values and Lessons

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Table of Contents

I. Preface
Eric Newell, ACR Education Committee Chairman and CEO and President, Syncrude Canada Ltd.....i
Roger Palmer, Assistant Deputy Minister, Student Programs & Evaluation, Alberta Education.....i
Joe Freedman, Medical Doctor.....i

II. Scene Setting.....1
III. Executive Summary.....2
IV. Major Findings.....4
V. Recommendations.....8
VI. Study Organization and Acknowledgments.....10

Reports
Report 1: International Curriculum Comparisons.....12
Report 2: Alternative Values, Schools and Futures for the 21st Century.....28
Report 3: Observations and Lessons Along the Way.....38

Alberta Chamber of Resources
in partnership with
Alberta Department of Education

I. Preface

Eric Newell, ACR Education Committee Chairman and CEO and President of Syncrude Canada

At Syncrude, we know full well the connection between education and business. Our complex and technically sophisticated business employs individuals with many diverse skills and educational levels ranging up to and including Ph.D. scientists. The *minimum* requirement for employment at Syncrude is a grade 12 diploma, and those individuals can count on many hours of additional on-the-job training and skill enhancement to enable them to function safely and productively.

In Canada, we must recognize the forces of global competition and the role of science and technology in reducing cost, improving reliability and quality. Our economic prosperity and standard of living depend on our ability to compete in the world and to that extent we must be open to lessons from the international community.

Increasingly, the business community views with alarm the low level of interest in science and technology and skilled trade careers among Alberta youth. There is a growing concern for the quality of education, particularly that obtained by those students who do not proceed to p st-secondary education. Often these students are not well prepared to enter the workforce.

This internationally oriented study, sponsored by the Alberta Chamber of Resources, was conducted in partnership with Alberta Education and the involvement of other education stakeholders. We firmly believe that such partnerships are an important means to promote communication and understanding and new approaches to education issues. Our future depends on all of us doing our part.

Roger Palmer, Alberta Education

We must have a strong economy to maintain the social systems that Canadians enjoy. A prosperous economy depends on educational excellence for all our students. The two are inseparable. The realization that the two 'prosperities' are so closely linked has led to increased involvement of the business community in setting the course for education.

Alberta Education welcomes this involvement. While the traditional stakeholder groups — teachers, parents, trustees and students — will continue to be the 'front line' of education, the involvement of the other sectors of society is crucial to our success.

Successful businesses continually assess the products and processes of their best competitors to learn how to improve. Educators must do the same thing. Examining other educational systems can provide us with invaluable lessons about what works and what doesn't.

However, our educational system is the result of the history, culture and values of our country. What works in Japan may not work in Alberta. We can't merely copy other countries, but we can improve our schools if we carefully adapt their successful practices to our context. This study is only a first step — but an important one.

Joe Freedman, Medical Doctor

Education in Canada is managed by an expensive array of provincial ministries, faculties of education, district education bureaucracies, and organizations of educators. It is of note that this study did not originate with any of them, nor would it likely have. That makes a significant statement about our system of education and about our nation's prospects in a global economy. Albertans are fortunate that their Minister of Education, the Hon. Jim Dinning and his ministry officials have enthusiastically responded to, supported and partnered this project.

It is crucial that we get our education right. We have not. To know that, one has only to take off one's parochial blinkers and look hard at the methods and outcomes of the strong systems of Europe and Asia. No one viewing Professor Harold Stevenson's eye-opening videotape, 'The Polished Stones,' can escape a feeling of panic and despair. Those classrooms work! Every observant parent senses that what is going on in those rooms is precisely what they want for their own children.

Fortunately, what parents want and what a country needs are the same: a strong curriculum, effective methods and a system that works. It is our further good fortune that the "quiet revolution in educational research" clearly spells out the practice necessary for student and school success. The bad news is that it is practiced best on the other side of either ocean.

This study wants repeating. However, this time it should be a national effort, a collaboration of one or more provinces, the federal government, and national organizations representing education, business, the professions and our post-secondary institutions. It should target the general and vocational streams of students who represent our nation's greatest problem. Efforts should be made to get not only the curriculum, but also the tests by which students demonstrate mastery.

There is a major disparity in education practices and outcomes that we ignore at our children's peril. Large numbers of Canadians need to see it first-hand to strengthen their resolve.

I'm optimistic. This study is in hand. The next will be easier if we have the will.

"Although Alberta has one of the strongest education systems in the country, things are not all well..."

II. Scene Setting

It was a day in November 1990 when Dr. Joe Freedman, a self-admitted activist for education reform, came to an Alberta Chamber of Resources (ACR) board meeting to make a determined pitch for an industry initiative.

Although Alberta has one of the strongest education systems in the country, the competitive world is leaving us behind, he insisted.

He showed examples of European physics texts from grades six and seven that were several years in advance of the Alberta curriculum; similarly, grade seven math examples that looked more like Alberta senior high school math.

Unfortunately, there were no definitive international achievement tests that compared Alberta directly with international systems; moreover, the Canadian comparisons that did exist were flawed and open to controversy. Why not prove the case by simply making a direct comparison of what is taught in Alberta versus other countries through an examination of textbooks?

Dr. Freedman's words fell on receptive ears. The Chamber had already established an Education Committee out of its concern for provincial education and had recently considered the proposed revisions to the Alberta high school science curriculum.

Additionally, during a 1990 partnership with Alberta Career Development and Employment and Alberta Education, ACR had conducted a significant and illuminating study of potential trade skills shortages in Alberta.

Aside from confirming that a skilled trade shortage was in the offing and that Alberta youth has lost an interest in trades, that study shone a light on some other disturbing facts:

- The average age of youth entering apprenticeship was found to be 27, approaching ten years after normal graduation from high school. This delay was believed to be at considerable cost to individuals and society.
- There was little dialogue between the three key players ultimately involved in skilled trades development: industry, the non-university post-secondary education community, and government. The study notes: "Industry rarely indicates what its expectations of the school are — though they are quite vocal in decrying the quality of the product!..."

The overall recommendation of the study was for industry to take a much stronger leadership role in education issues — through opening up dialogue, establishing partnerships and getting involved in issues.

There are many determinants of the education product ranging from socio-economic factors and societal values to innate ability, classroom life, what is taught and how it is taught. The idea of looking at what is taught as proposed by Dr. Freedman had appeal because it appeared objective and could be a useful product. Moreover, it was believed that transferable lessons would surface for the improvement of education in Alberta.

It was also clear to ACR that co-operative problem solving is the best way to influence policy and to change systems for the better. In short, ACR took up Dr. Freedman's suggestion.

The ACR-Government Partnership, already in place, was extended to conduct the curriculum study; agreement was confirmed with the Hon. Jim Dinning, Minister of Education, in March 1991.

Over a year has passed since that day in November 1990. The debate on education reform has escalated remarkably in the interim. In Alberta, Jim Dinning, Minister of Education, issued a milestone report, 'Vision for the nineties...a plan of action.'

This study is intended to add to the accelerating dialogue on the quality of education in Alberta, and to present a business perspective.

III. Executive Summary

International achievement indicators, research literature and reputable studies have led many to the conclusion that there is a serious quality problem with education — particularly with math and science education — in Alberta.

Many observers suggest that the responsibility for education outcomes lies not only with the educators in the province, but also with government and industry. Previous studies have strongly recommended that industry take a stronger leadership role in education.

In response to this concern, Alberta Education and the Alberta Chamber of Resources have partnered their resources to produce this study, a first step toward further industry-education dialogue on the issue.

The study offers an objective comparison of materials taught in grades seven to 12 in math, physics, and chemistry in the countries of Japan, Germany (West), Hungary, and the province of Alberta. These countries were selected for study because of their reputation for excellence in math and science, as well as economic pre-eminence (in the case of Japan and Germany).

In addition, the study examines the education system practice and societal context of each country or province.

Report One: International Curriculum Comparisons presents the detail of the objective text and curriculum comparison work, and sets forth methodologies, findings and implications.

Report Two: Alternative Values, Schools and Futures for the 21st Century gives an historical perspective of math and science education reform, discusses societal value trends in Alberta, and draws cross-cultural comparisons with Japan and European communities. Education system comparisons, conclusions and recommendations are also presented.

Report Three: Observations and Lessons Along the Way offers a business perspective of Alberta issues and further lessons from the international comparison. Implications and recommendations for specific sectors are reviewed and a view of the course of future development is offered.

The most significant observations that flow from the three reports are as follows:

- **Dismay is expressed for the two-thirds of students who do not proceed to post-secondary education.** Many of these students are ill-prepared for an increasingly demanding workplace. Too many drop out of formal education. As a group, these students are showing a decreasing interest in science and technology, and in skilled trades careers. School-to-work transitions are poor when contrasted to the comparison countries.
- **The comparison countries of Japan, Germany (West) and Hungary deliver more math and science to their students earlier and with more depth of treatment.** The introduction of physics and chemistry topics in Germany and Hungary is dramatically earlier. Even a cursory examination of German physics textbooks, for example, shows a markedly more sophisticated treatment than Alberta textbooks at the junior high level.
- **The study also notes that there is a large amount of counter-productive repetition in Alberta grades 7/8/9 math texts.**
- **The comparison countries were seen to have a strong focus on achievement, outcomes, national standards and tests, reflective of societal values supporting a strong work ethic, self-discipline and acquisition of specific skills.** In Alberta, societal values have drifted towards individualism, self-discovery and self-indulgence, and resistance appears to have built up against the operation of a more demanding, outcome focused education system.

"...(R)esearch literature and reputable studies have led many to the conclusion that there is a serious quality problem with education — particularly with math and science education — in Alberta."

"By far the major concern with education in this province is the quality of schooling obtained by the two-thirds of students who do not proceed to post-secondary education."

• **Several education practices were noted from the comparison countries that should be transferable to Alberta, regardless of societal differences.** These are in the areas of teacher preparation, apprenticeship, classroom organization and effective use of class time.

One area that demands further in-depth examination for transferable practices is the effective school-to-work transitions (particularly as exercised in Germany and Japan), which are fostered by a close linkage of business and schools.

This study is supportive of the vision and the priorities outlined in Hon. Jim Dinning's 'Visions for the nineties...a plan of action', and is heartened by the focus on achievement of academic excellence and the support for mathematics and science.

Nevertheless, more fundamental changes in the education system may be required to empower teachers to practice their profession to the best advantage. These changes are believed to be in the direction of fostering private school characteristics within the public school system, school choice, and establishing effective school models.

The study recommendations are synopsized as follows:

Stakeholder partnerships are seen as a way to promote communication, understanding and new approaches to education issues.

Business is in a position to publicize the connection between education and individual and national prosperity. At the same time, it needs to become more involved in education issues and partnerships and to communicate its expectations of the education system.

For educators, recommendations include more focus on academic achievement and improvement of education practices through learning from other effective models. Curriculum designers need to eliminate unproductive repetition and should consider the introduction of more science earlier.

Education policy makers need to continue enthusiastically with the focus on academic achievement as a top priority, and to do their part to facilitate improvement of education practices including incorporating lessons from effective school models.

IV. Major Findings and Recommendations

I. The Major Concern

By far the major concern with education in this province is the quality of schooling obtained by the two-thirds of students who do not proceed to post-secondary education.

Many of these students are inadequately prepared for a job market that is demanding ever-increasing formal education and the ability to participate in life-long learning. In effect, the transition from secondary schooling to work life is poor. Additionally, this group of students is showing a decreasing interest in technical careers and the skilled trades. Because this situation affects a majority of students, it is indeed a grave concern.

A striking difference between Alberta and the comparison countries is the attention paid to school-to-work transitions and the encouragement of vocations and skilled trades in those countries. These school-to-work transitions are supported by close relationships between schools and employers that are not found in Alberta.

II. Values

The set of values held by the public and by educators in Alberta has an overwhelming influence in the education system — and it is probable that ultimately, through a complex set of mechanisms, society receives the education system it most values.

Societal values in North America and in Alberta over the last several decades have drifted towards self-discovery, individualism, sensual indulgence, pursuit of personal happiness and self-fulfillment. As a result, resistance has built up against the operation of a more rigorous educational program with higher achievement standards for all students.

As well, teachers are increasingly faced with problems of student indifference, disobedience, unfavorable work habits, and non-academic distractions. Sometimes they are assuming roles normally attributed to social agencies and parents.

In contrast, the value systems of the comparison countries are characterized by a dominance of economic values, a strong work ethic, self-discipline, co-operation, and acquisition of specific skills. As a result, their educational systems are strongly outcome-, result- and achievement-oriented.

From an industry perspective, the link between education, fulfilling jobs, and economic prosperity is clear. However, the quality of the education system product is not good enough. To the extent that education is influenced by public values, it is necessary to promote more public awareness of the linkage of education to prosperity. There must be more focus on achievement and outcomes from the education system. The value choices for Albertans deserve to be publicly debated. Educators have a role both to lead the debate and ultimately to reflect the wishes of the society they serve.

III. Textbooks and Curriculum Design

There is a major concern with the large amount of repetition of concepts in Alberta grades seven/eight/nine math texts. For example, of 163 concepts introduced in the grade seven text, all but three are repeated in the grade eight text. This repetition is beyond that intended in the curriculum. It may also be a manifestation of the spiral curriculum mode of instruction which encourages repeated coverage of material, each repetition presumably at greater depth of understanding. Excessive repetition can lead to a diffusion of teacher accountability for imparting mastery of a concept, student boredom, and a culture of repetition rather than doing it right the first time.

Physics and chemistry are introduced earlier and with more advanced

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"The incidence of part-time work among students is an increasing distraction to academic achievement in Alberta."

treatment in the European countries and are taught as discrete subjects beginning as early as grade six. Thus, the language of physics and chemistry is introduced earlier to younger, perhaps more receptive minds.

In Alberta, the foundation science of physics seems to be viewed as a formidable subject. Introduced as a discrete subject in grade ten, the participation rate is half that of biology or chemistry.

Specific mathematics concepts were also found to be introduced earlier in Japan and Germany than in Alberta, although not dramatically so. For example, calculus was found to be introduced in grade 11 compared to grade 12 in Alberta.

That other students are succeeding with more science and math earlier may be evidence of deeper differences in educational systems. A comparison of actual test materials would help to illuminate what students actually master with earlier introduction of science, something that was beyond the scope of this study.

Alberta textbooks tend to be bulkier, heavier, and more expensive. They are also more wordy and contain more distracting material than those in the comparison countries. By comparison, the Japanese texts are compact, terse, concise and inexpensive paperbacks, some invitingly illustrated and all student-owned. German textbooks are more compact and more sophisticated at the equivalent grade levels than those of Alberta.

In general, Alberta textbooks seem to contain more information than required in an attempt to convey the course without teacher intervention. The comparison countries, especially Japan, clearly place more reliance on active teacher and student participation.

The notion of spiral curriculum instruction (that is, gradual exposure accompanied by review and repetition) appears confined to North America. To the extent that the spiral curriculum leads to undue repetition and dispersion of teacher accountability for imparting specific concepts, the method is suspect. The comparison countries use direction instruction methods (that is, teach, test and review concepts in a cumulative sequence with minimal repetition.)

The direct instruction method is being piloted in Alberta (at the Fort McMurray Catholic School Board system) from kindergarten to grade 12 mathematics with promising results at an early stage. The methodology is based on principles of clarity of desired outcomes, clear standards, teacher accountability, high expectations and mastery of concepts by all students along the way, confirmed by testing. It is strikingly similar to Japanese practice.

IV. Emphasis on Achievement and Outcomes

The comparison countries are seen to be much more concerned with mastery of curriculum content and outcomes than Alberta. Those countries design structures in their system to support the notion that content mastery and hard work count.

Japan is the most demanding in this respect, requiring entrance exams for senior high school and subsequently for university. The academic streams in Germany and Hungary are subject to diploma exams. All the comparison countries including Germany (West), which like Canada delegates education to its individual states, subscribe to the concept of education standards and the mastery of core content.

V. Part-Time Work

The incidence of part-time work among students is an increasing distraction to academic achievement in Alberta. On average, 50% of students aged 15 to 19 work part time; in some schools, 80% of the students work.

In Japan, only 20% of students work — education is their top priority. In Germany, students are required to participate in formal

education while working until age 18; their work experience is most often geared to a vocation.

The reasons for the incidence of part-time work in Alberta are many, and in some cases dictated by economic necessity. Nevertheless, strategies to understand the impact of part-time work on academic achievement and to mitigate adverse effects should be considered.

VI. Class Time Utilization and Discipline

The effective use of class time may well be the most significant factor impacting achievement and outcomes of education. Clearly, lost time is lost opportunity, something that business understands to be vital to success.

Asian schools (Japan, Taiwan and China) appear to utilize available class time better than U.S. or Alberta schools. In those systems, more efficient use of class time contributes to more effective lessons.

The related issue of classroom discipline (too often violence) is often cited as a growing and serious problem in Alberta. Some would say that all educational improvement attempts will fail at the door of discipline.

There are no recent studies in Alberta on the issues of class time effectiveness and discipline, although anecdotal evidence abounds. The degree, distribution and magnitude of the problem deserves immediate comprehensive understanding through independent direct classroom observation. We should seek transferable lessons from other systems to improve our classroom efficiency and effectiveness.

VII. Class Organization

Classroom organization also plays a part in effective learning. Asian teachers teach only three to four hours per day and spend an important part of the remainder of the day in collaborative preparation of lessons. They teach in front of much larger classes but these classes are more intense with superior lessons continuity and consistency of teaching practice. They seek to hone the delivery of concepts into memorable internalized experiences.

In contrast, Alberta teachers spend more of the day teaching, and to smaller classes. Lesson preparation, a key to effective learning, occurs in solitude and often at home. This lack of professional collegiality presents particular difficulties for new teachers. Curriculum changes would also be accommodated more effectively with greater professional collaboration.

VIII. Math/Science Education

The declining interest in science and technical careers and in the skilled trades, in the face of increasing need, is disconcerting to industry.

Canada's economic future will increasingly rely on improving the wealth creation from its rich natural resources. This means creating added value by applying knowledge and technology to improve goods and services and to invent better ways to perform old tasks. Our economy and standard of living are inextricably linked to excellence in science and technology.

Yet three decades of persistent calls for improvements in science education have produced little progress. Strong and immediate action is called for — now. These actions to be effective should be focused on science instruction in the school with the objective of more and better science to more students.

Unfortunately, there appears to be a serious and growing shortage of math/science teachers in Alberta, this in the face of increasing competition for technically qualified individuals in other fields. A low proportion of students major in science and mathematics in the teacher preparation institutions. Moreover, some 25% of all Alberta teachers will retire within the next ten years.

"Our economy and standard of living are inextricably linked to excellence in science and technology."

"...(W)eak schools will wither away for lack of support, effective schools will flourish."

In the comparison countries, teaching is a respected and honored profession, and it attracts very qualified individuals. In Japan, there are reported to be five applicants for every teaching position. Teachers are well qualified in mathematics and science, and many are attracted from industry and other fields. Teacher apprenticeship and in-service programs are well developed.

Strategies to encourage the entry and retention of individuals into mathematics and science teaching, from high schools and from other fields, must be developed, coupled with effective apprenticeship and in-service programs. Teacher training institutions should be deeply involved in these strategies and should seek to develop close and supportive relationships or partnerships with the schools to which they provide teachers.

IX. National Standards

In comparison with Asian and European countries, education in Canada is fragmented and lacks national perspective.

Twelve relatively small jurisdictions in Canada are engaged in setting policies and standards, establishing curricula and texts, setting and implementing priorities, largely from their parochial perspective. There is no national consensus on core curriculum, standards nor achievement.

The comparison countries look appealing in contrast and have national priorities, national standards and achievement measures.

Some steps are being taken to address this problem. For example, the Council of Education Ministers, Canada with Alberta and Quebec in lead roles is designing national achievement indicators in mathematics, reading and writing. The Federal government has also entered the field with a call for a national perspective on education.

X. Money and Education

Alberta is a relatively high spender on education on a world scale. Expenditures in Alberta education have quadrupled since 1975 while student enrollments have remained static.

North American research shows strong and consistent evidence that the level of expenditures on education is not directly related to student achievement and as a corollary raises questions about the apparent waste of resources. The lessons that business and many other institutions have had to learn in an increasingly competitive world is that improved quality, reliability and productivity can (and must) be obtained in the face of real cost reductions.

The policy implications are that the solution to educational problems is not more money.

XI. Partnerships

Partnerships between educators, industry, the public and other education stakeholders are becoming popular in North America and Alberta as a collaborative approach to improving education.

Such partnerships in Alberta are leading to a number of useful initiatives and can be effective at a policy and a local school level. Partnerships promote communication and mutual understanding, increase available resources and stimulate new approaches to issues.

At the same time, it is noted that a number of well-meaning initiatives fail for lack of clarity or focus on common goals and priorities. As well, some initiatives in effect constitute tinkering at the edge of a largely immovable system.

In Japan and Germany, many partnerships exist, but to a higher degree of development. Most are oriented toward providing effective transition from post-secondary schooling to work life. Germany reports 500,000 partnerships in operation. Japanese high schools operate student placement centres and even provide guidance after a student has graduated.

XII. Alberta Policy Initiatives

In October 1991, the Minister of Education, the Honourable Jim Dinning issued a milestone report entitled 'Vision for the nineties...a plan of action.' The vision for Alberta education is described as excellence for all Alberta students with a focus on goals, results and accountability. Priorities for action focus on standards and results, and enhancements in curriculum, basic skills, science, teaching, student equity and partnerships.

Public dialogue of the plan has been initiated. There is much in the document that the observations and findings of this report support. There remains however an uneasiness that the dramatic education improvements that are envisioned may not be possible to implement in the face of a large and established system. It may be necessary to introduce more fundamental changes to the education system itself.

XIII. Choice and Effective Schools

Many of the current calls for education improvement are tied to the concepts of goals, accountability, measure outcomes and performance. From its experience, business would add the element of choice in schooling, whereby schools would compete for students on the basis of school merit.

Japan operates such a system with competition and entrance exams for its public senior high schools. Recent major changes in the British school curriculum have resulted in local school governance, school choice, publicized school results and funding proportion to enrollment. The concept is that weak schools will wither away for lack of support, effective schools will flourish.

In some U.S. cities, the concept of focused effective schools is emerging. This ideal would deliver a private school product within a public school system along with local school governance and family choice. Marked improvements in outcomes are noted in these effective schools, even under very adverse socio-economic circumstances.

Some of the characteristics of these effective schools are noted to be: school self-governance, excellent principals, meritocracy with teachers, families there by choice, community involvement, clear and high expectations, classroom effectiveness, and high curriculum and achievement standards. These schools go a long way towards improving the chance for a successful learning transaction by improving the environment in which the transaction takes place. Restructured decision making provides schools with more local authority and accountability for strategy, budgets, staffing, scheduling, curriculum and procedures. Teachers are empowered with more flexibility, opportunity for collaboration, and professional development to effectively exercise their profession.

The piloting of schools with those characteristics, particularly in disadvantaged areas, is to be encouraged in Alberta. Such schools have the potential to be a model for substantive change to the shape of education in Alberta.

V. Recommendations

Recommendations for Stakeholder Partnerships

Partnerships of stakeholders in education, at all levels from the policy level to the local school level, should be actively encouraged as a means to promote communication and understanding, to increase available resources, and to stimulate new approaches toward education issues. These partnerships should:

1. Focus more attention on the quality of education available for the two-thirds of students who do not proceed to post-secondary education.

2. Learn from successful models in other countries by examining in detail the structures and the mechanisms that provide effective transitions from secondary schooling to work life.

3. Create an information campaign designed to promote understanding of the linkage between education and economic prosperity, to foster work ethic values, and to publicize and debate the value choices and their consequences for Albertans.

4. Promote and popularize interest in science and technology skilled trades careers.

5. Support present efforts to provide a general science curriculum for all secondary school students, without jeopardizing specialized science courses for those students majoring in those fields.

6. Support the early establishment of a Centre of Mathematics and Science Instruction with members including professional educators, business, government and the public. The Centre would be a focus of mathematics and science instruction innovation, and a monitoring and co-ordinating group for the advancement of math and science education in the province.

7. Examine the incidence of part-time work and develop strategies to reduce any detrimental effect such work has on academic achievement.

8. Publicize the importance of parenting to academic achievement, and support and encourage parenting programs.

Recommendations for Business

1. Play a much more active and effective role in improving school-to-work transitions, particularly for the two-thirds of students who do not proceed to post-secondary education.

2. Publicize the link and the role of science, technology, and skilled trades with national and individual economic prosperity.

3. Communicate more clearly its expectations of student skills for the current and evolving job markets.

4. Play an active role in stakeholder partnerships at all levels, from the policy level to the local school level.

5. Encourage and support the participation of employees on local school boards.

Recommendations for Educators

1. Ensure that Alberta's education system contains sufficient structures and mechanisms in place to demonstrate to the student that hard work is important. Strengthen and maintain structures supporting outcomes and mastery of core curriculum such as achievement tests and standards.

2. Take immediate steps to determine and understand the effectiveness of use of class time, and the degree, nature and distribution of discipline problems through independent direct classroom observation. Compare the results with effective schools and with effective systems in the world with a view to developing strategies to address class room time effectiveness.

3. Experiment with the size and organization of Alberta classes to allow more time for more collaborative lesson preparation by teachers.

4. Redesign the grades seven/eight/nine mathematics textbooks to eliminate undue repetition and any other unproductive repetition in the curriculum. Encourage direct instruction pilots in mathematics

and consider the same for other subjects.

5. Reflect the ability of students to take more mathematics and science earlier in the curriculum, even at an elementary school level. Examine test materials to understand what students of other countries master through earlier mathematics and science instruction.

6. Re-examine the textbook design and selection philosophies and the role of the textbook in instruction for cost and effectiveness, learning from international examples.

7. Strengthen and maintain the provision of realistic information to parents and public about student and school achievement and outcomes.

8. Encourage the teacher preparation institutions to form a closer and more supportive relationship or partnership with the schools.

Recommendations for Education Policy Makers

1. Establish academic achievement as a top priority.

2. Continue to vigorously pursue public debate and understanding of education issues and to provide leadership in implementing the priorities identified in 'Vision for the nineties...a plan of action'.

3. Seek solutions to problems in education, not through higher expenditures, but rather through efficiencies and, if needed, program scope reductions in lower priority areas.

4. Develop strategies to overcome current and future shortages of qualified mathematics and science teachers including opening opportunities from science professionals in other fields.

5. Upgrade teacher qualifications in mathematics and science by requiring all future teacher candidates to complete high school diploma level mathematics and science course work. Require secondary-level teachers of mathematics and science to have specialist qualifications in those fields.

6. Encourage more teacher apprenticeship and in-service program development.

7. Monitor and undertake to continue to learn from effective school models and consider initiating effective school pilots in Alberta, particularly in disadvantaged areas.

8. Support national initiatives that develop a national perspective on education in terms of priorities, achievement indicators and national standards.

VI. Study Organization and Acknowledgements

The study was managed by the Alberta Chamber of Resources through a Study Manager (Edward Pacholko) reporting to a Steering Committee:

Dr. Joe Freedman: Medical Doctor

Eric Newell: CEO and President Syncrude Canada Ltd.

Dr. Roger Palmer: Assistant Deputy Minister, Student Programs & Evaluation, Alberta Education

The Assessment Committee included:

Dr. Heidi Kass: Professor of Science Education and Research Design, University of Alberta

Dr. Roger Palmer: ADM, Alberta Education

Dr. Norman Wardlaw: Professor of Geology and Geophysics, University of Calgary

Paul Wozney: Physics teacher, Beaumont Composite High School

This committee advised on the preparation of the objective comparison work and the overall report.

The Department of Education undertook the task of obtaining text

and curriculum materials. It also commissioned the portion of the study prepared by Dr. Robert Patterson, former Dean, Faculty of Education, University of Alberta.

Daryle Tilroe, a fourth year honours Math/Physics student was engaged to complete detailed curriculum comparison work.

Mathematics- and science-qualified translators assisted:

Dr. Zoltan Berkes, Concordia College: Hungarian

Dr. Nancy Cyr, Alberta Research Council: Japanese

Helga Petri, AOSTRA: German

Considerable data and expertise were obtained from Dr. Harold Stevenson and his colleagues at the Center for Human Growth and Development, University of Michigan.

Editing and formatting of the study document was by Kerry McArthur, Westword Communications.

Our gratitude to the many stakeholders who contributed to the study. Sponsors of the study included Syncrude Canada Ltd., Suncor Inc., Mobil Oil Canada, Ltd. and International Cooling Tower Inc.

Report 1:

International Curriculum, Comparisons

A paper prepared by Daryle Tilroe, fourth-year Honours Math/ Physics student, University of Alberta, and E.J. Pacholko, Management Consultant

I. Introduction

Over the past decade or more, there has been a growing concern over the 'performance gap' between North American students and their counterparts — a gap particularly in evidence when examining the scores of students on achievement tests. Moreover, there is an increasing belief that the emerging dominance of countries like Japan and Germany is having a definite effect upon business, technology development, and the economy on this continent.

What is the cause of this performance gap — and does it in fact exist? Critics of international studies suggest that such comparisons are hopelessly flawed: factors like comparability of student samples, different curriculums, emphasis and cultural priorities are often glossed over in the process. Selective reporting of results often leads to misleading messages.

This study was designed to avoid some of the international testing pitfalls by directly examining text and curriculum documents. For example, a cursory look at grade six and seven physics and grade seven mathematics textbooks from Czechoslovakia reveal that topics on both subjects are introduced several years before comparable Alberta texts. If students from other countries are learning and mastering mathematics and science concepts earlier, then the textbooks become *visible milestones of progress*.

Mathematics, physics, and chemistry were chosen as comparison subjects for the study for a number of reasons: the body of knowledge is universal, uses common symbols, and lends itself to ready objective comparison with minimal translation difficulty.

As well, a declining interest in science, technology, and skilled trades careers in this province has caused concern in Alberta business circles. Our ability to compete in the global economy depends upon our mastery of these selected subjects. Also, international achievement tests have focused on mathematics and science.

The comparison was conducted using grades seven to 12 materials in order to limit the study to a manageable scope and also because some international tests show a deterioration of performance during the secondary school years in Canada. There was also some attempt to shed light on the preparation students receive in other countries prior to entering post-secondary education or work life.

The comparison countries of Japan, Germany (West) and Hungary were selected because of their reputation for mathematics and science education excellence, and for economic pre-eminence, in the cases of Japan and Germany. In addition, this selection of countries reflects two different cultures, Asian and European.

Different countries stream their students towards academic, general or vocational careers at different points in time. This did not present as formidable an obstacle to the study as one might suppose. Alberta and Japan stream their students after grades nine and 10 respectively, Hungary after grade eight, In Germany, streaming into several school types begins at grade five. Nevertheless, Germany emphasizes the idea of a strong comprehensive core curriculum which is obligatory for all students irrespective of school type. The education system in the state of Hesse was examined. There, the same curriculum document for secondary level I, grades 7 to 10, math, physics and chemistry is applicable to the four main school types (although the level of mastery may vary), and the same number of hours are devoted to each subject.

Thus, the majority of students took a common curriculum through grade nine or 10 in the jurisdictions studied. The academic stream was then considered for the remaining years in each country. It was not practical to examine the vocational streams because of the wide variety of schools and curricula.

"The comparison countries of Japan, Germany (West) and Hungary were study subjects because of their reputation for mathematics and science excellence..."

Two different comparisons were made in the course of this study using two different but conceptually similar methods.

The first was the comparison of Alberta mathematics curriculum with Japanese and German curricula (also American) in grades seven to 12 inclusive. Here, the actual text books were used as the primary source of curricula. Our methodology was patterned on work performed by Harold Stevenson in 1985 at the University of Michigan. In its simplest form, the methodology consists of defining a series of concepts that comprise the body of knowledge, extracting and comparing the concepts from respective textbooks. Depth of treatment at the time of introduction was also examined by looking in detail at a representative sample and converting relative depth of treatment to a time equivalent.

The second comparison was Alberta physics and chemistry courses to those of Japan, Germany and Hungary. Here, the primary source of the curricula was official curriculum documents. The concept list used was a modified list of concepts employed by the Second International Science Study. Depth of treatment was analyzed in a manner similar to mathematics.

The primary analysis prepared in most cases was a determination of when concepts were introduced in the comparison countries relative to Alberta. That was coupled with analysis of depth of treatment for selected cases. The qualitative results are shown in the chart below.

Data available for Japan, Alberta and the U.S.A. made it possible to study math concept repetition in some detail. Alberta math texts were seen to have significantly more concept repetition than did the Japanese texts. This repetition is at its worst in the junior high school grades of seven, eight and nine. In fact, the respective texts of these grades, most notably seven and eight, are virtually interchangeable.

This repetition may be a manifestation of the spiral curriculum educational philosophy predominate in North America, whereby concepts are introduced a number of times at presumably higher cognitive levels. Repetition tends to diffuse teacher accountability for imparting a concept and leads to student boredom or disinterest. Worse, it may lead to a culture where repetition rather than mastery is the normal expectation.

A comparison of the textbook format of respective countries is also of interest. Japanese texts are student-owned, terse, compact, and inexpensively bound. In contrast, Alberta texts contain much extraneous material, are thick, expensive, and attempt to contain sufficient material to convey the subject without teacher intervention. German texts are more compact and much more sophisticated in treatment of concepts and illustrations. Hungarian texts are very similar to Japanese text books.

In general, math and science are delivered earlier to student in the comparison countries, and in some instances, dramatically earlier — and to that extent, text books are visible milestones of the material students are offered. Note that this does not mean earlier introduction is better — simply that it exists. Germany and Hungary introduce physics and chemistry in grades six and seven. Possibly, younger minds are more receptive to the language of math and physics.

In any case, curriculum designers in Alberta should take a lesson from the comparison countries and not underestimate the capacity of students to learn more math and science earlier. Examination of actual test materials to determine what students master through earlier introduction would be useful, as would detailed comparison of the relative timing and mastery of specific concept categories.

Particularly in Germany and Hungary, a large proportion of students proceed to vocational

schools after grade 10. Because of the dramatically earlier introduction of physics and chemistry in those countries, the students are better equipped to manage the technical component of their vocations than is the case in Alberta. There is leverage in improving the quality of education to those Alberta students who do not participate in post-secondary education. Again, lessons are available from the comparison countries.

That students do take and apparently master concepts in secondary school math and science earlier in the comparison countries than in Alberta is probably a manifestation of deeper differences in the respective education systems, reaching down into the elementary level.

II. Materials and Methods

A. Mathematics

To conserve resources and effort, the mathematics analysis was based on work done in 1985 by Dr. Harold Stevenson, the Center for Human Development, University of Michigan[1]. In the course of constructing an international achievement test, Stevenson extracted a detailed list of concepts from the most popular textbooks of Japan, the U.S.A. and Taiwan. Qualified coders from the respective countries were engaged to extract the concepts. Stevenson's work was available to this study in the form of a summary document, and subsequently in the form of a detailed concept list.

For logistical reasons, the preliminary extraction of concepts from the Alberta texts was done without Stevenson's list of concepts. The texts (see Appendix 1) used in this study were the most popular texts of their kind in Alberta, and were analyzed in their entirety (except for four chapters in Math 31, which are not generally taught). With a few exceptions, the definition of a concept was not hard to realize, and the initial number extracted compared favourably with Stevenson's numbers.

Subsequently, this preliminary list was merged and reconciled with Stevenson's concept list totalling 521 concepts. The concepts were recorded on cards along with a concept file number, the point of introduction of the concept in Japan, and the point of first introduction in Alberta and subsequent repetitions. Stevenson's concept list was extended with those Alberta concepts that remained unclassified. The list was audited by Florence Glanfield of Alberta Education and appropriate adjustments were

"Repetition tends to diffuse teacher accountability for imparting a concept and leads to student boredom or disinterest."

Introduction of Concepts:
Timing Relative to Alberta:
Grades 7 - 12

	Japan	Germany	Hungary
*Math w/o depth**	Earlier	Earlier	N/A
Math with depth	Much Earlier	Much Earlier	N/A
Physics w/o depth	Similar	Much Earlier	Much Earlier
Physics with depth	Earlier	Much Earlier	N/A
Chemistry w/o depth	Similar	Much Earlier	Much Earlier

** without modification for depth of treatment*

"...(C)urriculum designers in Alberta should take a lesson from the comparison countries and not underestimate the capacity of students to learn more math and science earlier."

made. The final product was a list of 546 concepts of which 458 were found in Alberta texts.

For the depth of treatment analysis, a proportional stratified random sample was constructed of the concepts common to Alberta and Japan. The concepts were already stratified into 17 general categories by Stevenson and a 10% proportion of each category was then sampled. This 32-concept sub-sample was then located in the Japanese texts (see Appendix 1).

The depth modification was somewhat subjective, and basically consisted of interpolating how many years earlier or later a concept from a comparison country would have been introduced in Alberta at the same level of complexity. In practice, if a concept was found to be introduced with more depth in a comparison country, it would be assigned a time equivalent of one or two years earlier. Depth of treatment was related to such points as the degree of complexity introduced, clarity and completeness of theory, and the difficulty of example problems (see Appendix 2).

The 32-concept sub-set was also located in the German texts (listed in Appendix 1) to evaluate the timing and depth of treatment in Germany.

B. Physics and Chemistry

The method for extracting concepts for physics and chemistry was more streamlined. A tabular list of the modified Second International Science Study document 35 (Rosier & Couper, 1981) concept framework was prepared. The timing of the first introduction of the concept was noted on the list for each of the comparison countries and Alberta. The grade at introduction was ascertained primarily from the then current (1991) curriculum documents for the respective countries. Where there was an imminent change in curriculum, the new curriculum was used. Texts were consulted where required for clarification on specifics.

For the depth analysis, only physics was examined due to the time-intensive nature of the work. The sub-sample for the depth analysis was a systematic sample from the common concepts of Alberta/Japan (every 7th for 40 concepts) and Alberta/Germany (every 9th for 40 concepts). The depth modifications were done in the same matter as for mathematics (see Appendix 1 for texts consulted.)

C. Limitations of the Data

Following Stevenson's hypothesis that textbooks are the most representative of what is actually taught in mathematics, textbooks in the study were analyzed and not the official curriculum. In the opinion of Alberta Education and math consultants from the Edmonton public and private school boards, this hypothesis is quite accurate for junior high education in this province.

In senior high school, however, the curriculum documents are followed more closely and teachers tend to have a greater awareness of the differences between the curriculum and the text. In the course of the aforementioned audit, some eight chapters were excluded from the analysis because they were known not to be introduced in Alberta and to better represent the state of affairs in the classroom.

Neither the recommended texts nor the official curriculum documents can capture totally the classroom product. What is actually taught in the classroom and perhaps more significantly, how the material is taught, is primarily dependent on the teacher. Therefore, in practice, there will exist some departures from the official sources used in this study.

III. Analysis

A. Math

1. Delivered Body of Knowledge

The body of knowledge as embodied in the concept list totals 546 concepts. The portion delivered in the countries for which we have data is:

Alberta 458
U.S.A. 412

Japan 402

The concepts common to country pairs are:

Alberta/Japan 358

Alberta/U.S.A. 369

Japan/U.S.A. 329

These figures could be misleading if interpreted to mean that less is taught in Japan than in Alberta or the U.S.A. In Japan, it is likely that some of the concepts were introduced prior to grade seven, for which we have no data. Overall, the respective body of knowledge delivered appears comparable.

2. Timing of Introduction

The differences in the timing of concept introductions common to Alberta/Japan and Alberta/U.S.A. were tabulated in years and were subjected to statistical analysis. These data are displayed as a histogram, overlain with a normal distribution curve in Figures 1 and 2. Visual inspection of the histograms adequately conveys the results, ie. Japan is seen to introduce concepts slightly earlier than Alberta. The U.S.A. timing is strikingly similar to Alberta's.

For those more oriented to statistical analysis, Japan is seen to have 358 (n) concepts in common with Alberta (see Figure 1). The mean time of introduction (u) is 0.2 years earlier for Japan. The standard error (s) of the sample is 1.3 years (ie., statistically about 68% of the data falls within 1.3 years of the mean difference.) A paired student test (not shown) resulted in the Japanese introduction difference being accepted as earlier

"It can only be concluded that if international achievement tests are legitimate measures, then the typically superior performance of Japan does not lie in a dramatically different curriculum."

Figure 1:

Japan Math Concept Introduction

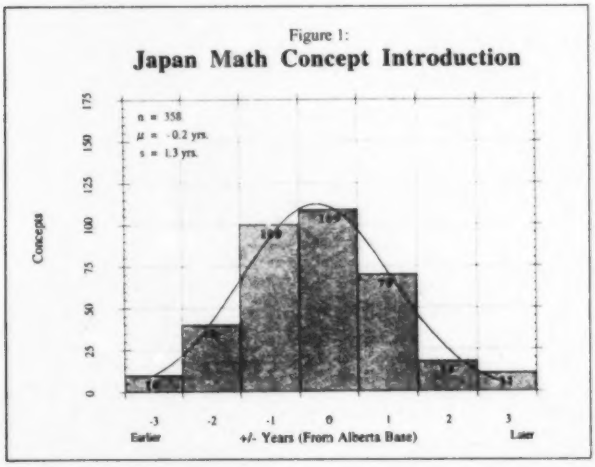


Figure 2:

USA Math Concept Introduction

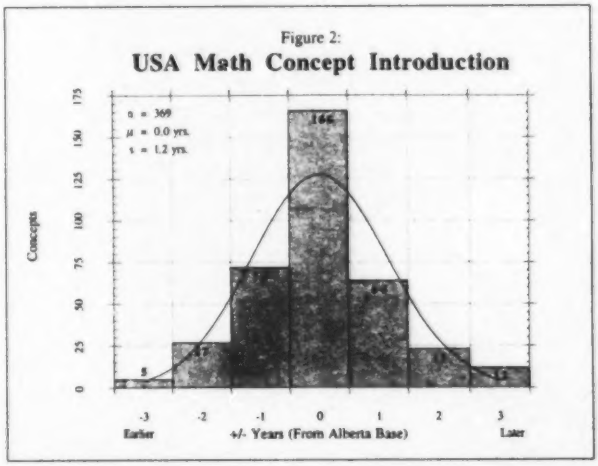


Figure 3:

Japan Math Concept Introduction
32 Sample-Our Data with Depth Modifiers

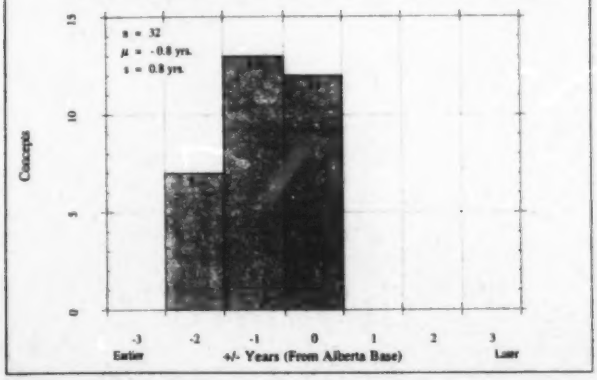
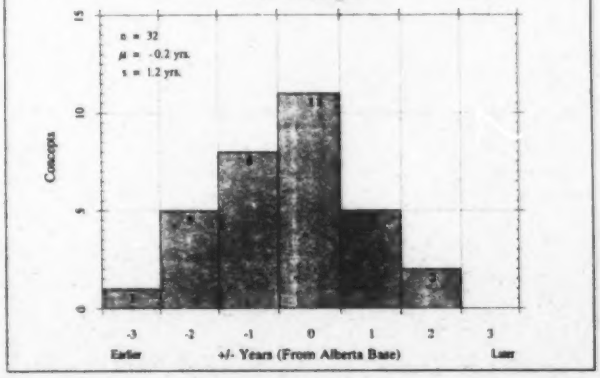


Figure 4

German Math Concept Introduction
32 Sample



"...(T)extbooks are the most representative of what is actually taught in mathematics..."

with a certainty of 99%. The stratified random sample subset of 32 concepts was statistically validated to be representative of the total population, and was then used to develop the depth of treatment modifier.

A discrepancy arose at this point: the timing of introduction as found in our texts did not always agree with Stevenson, and biased the data to a further 0.3 years earlier. With the depth of treatment modifier, the timing was modified to 0.8 years earlier (see Figure 3). Visually, Figure 3 would suggest that after depth modification, the majority of concepts are introduced one or two years earlier, and none are introduced later. Concept categories introduced markedly earlier (one or more years) include linear algebra, polynomials and calculus. Alberta introduces statistics and probability earlier.

The 32-concept sample list was then used to estimate the timing of introduction of mathematics concepts and the impact of depth of treatment in Germany. The results are displayed in Figure 4 and 5, and demonstrate a much earlier introduction when depth of treatment is considered.

3. Concept Repetition

The concept repetition rate was developed for those countries where data was available (see Figure 6). A high rate of concept repetition for Alberta is evident. For example, about 35% of concepts are repeated twice in Alberta compared to about 6% in Japan. Grade by grade repetition in Alberta is displayed in Figure 7. Of 163 concepts introduced in grade seven, 160 are found in the grade eight text.

Figure 5:

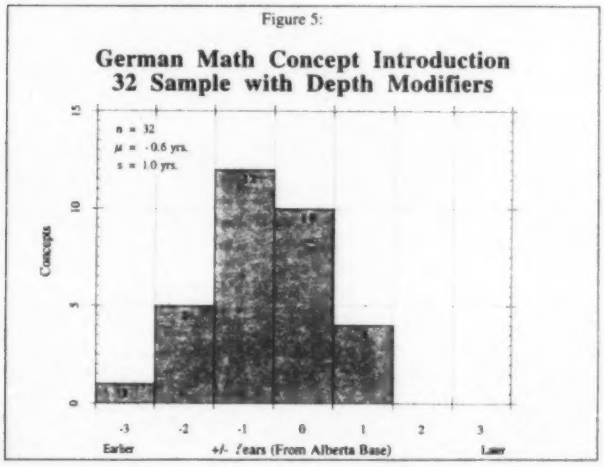


Figure 6:

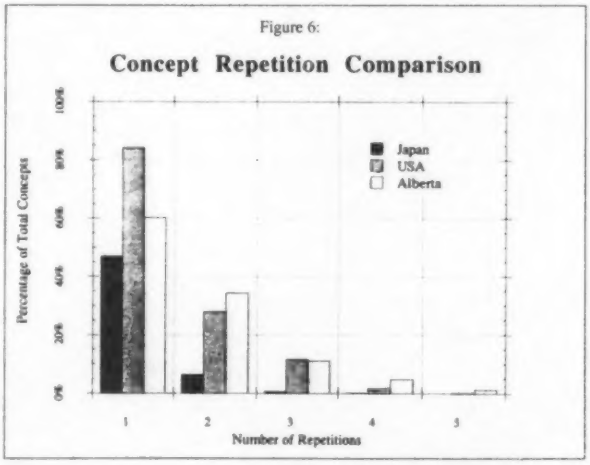


Figure 7:

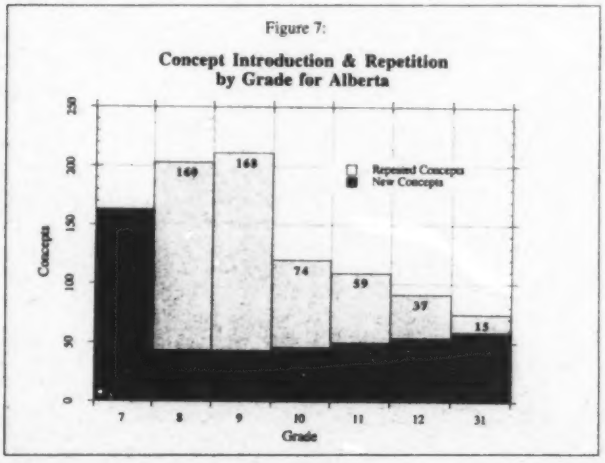
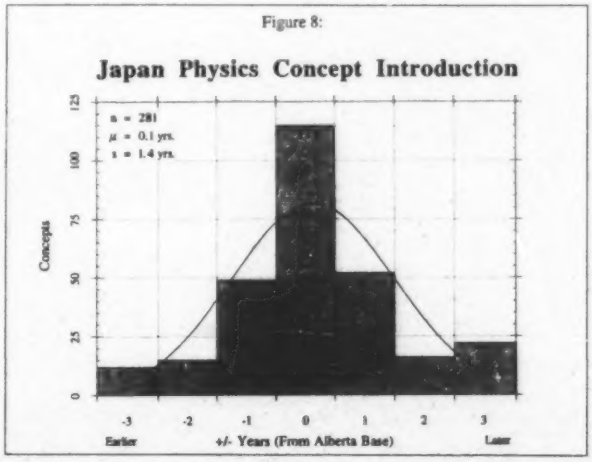


Figure 8:



An example of Alberta text repetition is provided in Appendix 3.

B. Physics and Chemistry

1. Timing of Introduction

The timing analysis method for physics and chemistry was similar to that for mathematics. Histograms of the results are displayed in Figures 8 to 13. Visually, Japanese physics and chemistry concepts are seen to be introduced with very similar timing to Alberta. However, the concepts in the two subjects are introduced much earlier in Germany and Hungary. In Hungarian chemistry, an incomplete curriculum document set leads to fewer concepts being assigned a grade with certainty. Chemistry is introduced in grade seven (physics in grade six) as a discrete subject, and the data shows one of the most dramatic timing differences, with 80% of concepts introduced one to three years earlier.

2. Depth of Treatment

As for mathematics, the sample subsets were verified by statistical analysis to be representative of the total population. Japan physics, modified for depth of treatment, is biased toward earlier introduction (see Figures 14 and 15.) The already-noted earlier timing for German physics is further advanced by the depth of treatment analysis such that nearly 60% of concepts are indicated to be introduced one to three years earlier.

"The repetition in the Alberta junior high mathematics texts is undesirable. It can only lead to confused accountability for imparting a concept, and undoubtedly leads to student boredom."

Figure 9:

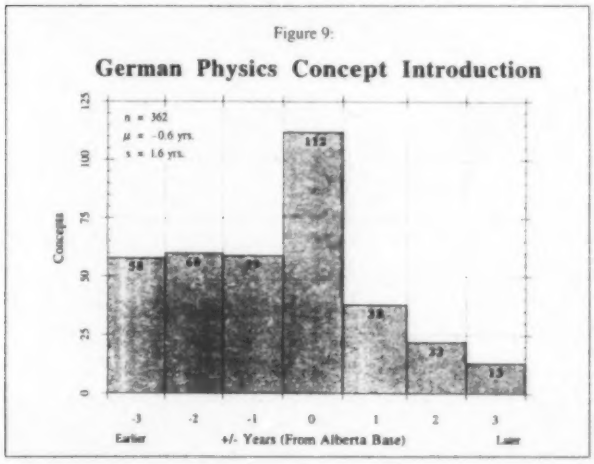


Figure 10:

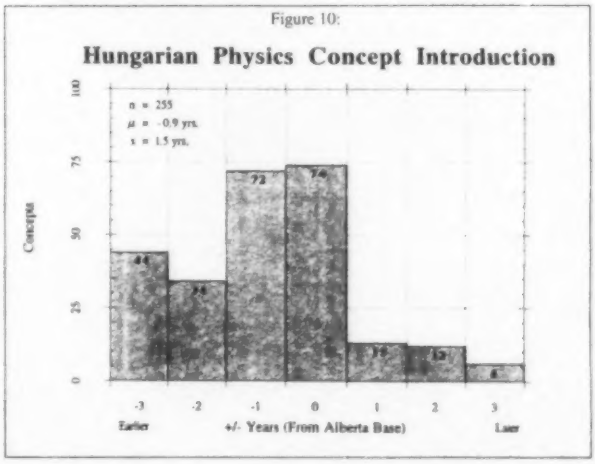


Figure 11:

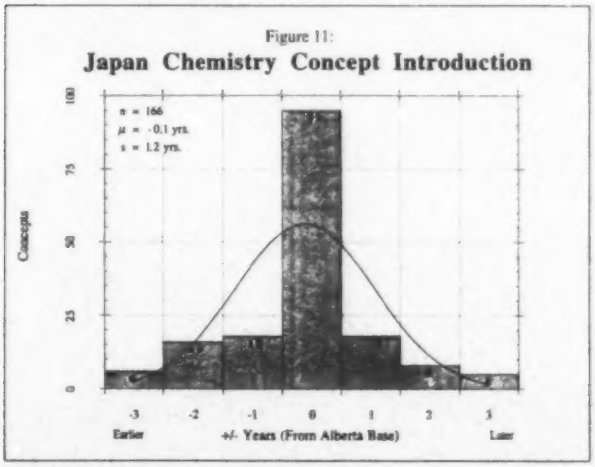
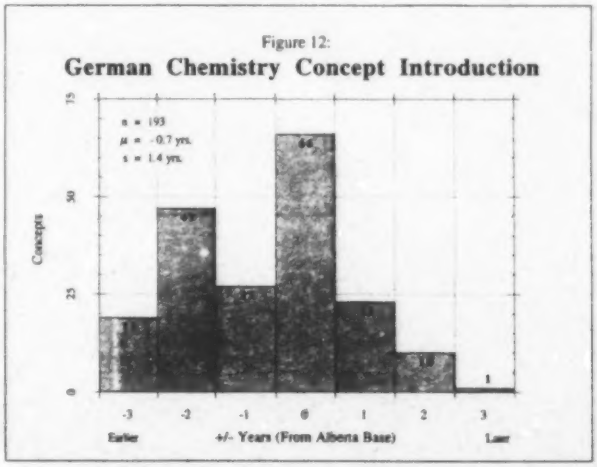


Figure 12:



"What is actually taught in the classroom, and perhaps more significantly, how the material is taught, is primarily dependent on the teacher."

Figure 13:
Hungarian Chemistry Concept Introduction

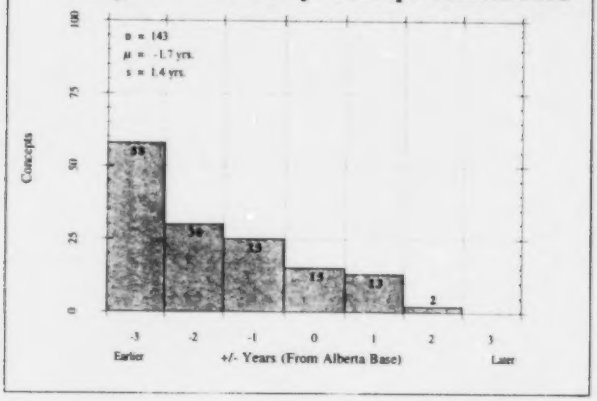


Figure 14:
Japan Physics Concept Introduction
40 Sample with Depth Modifiers

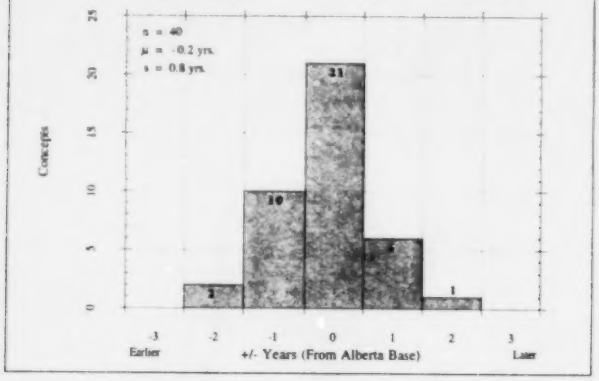
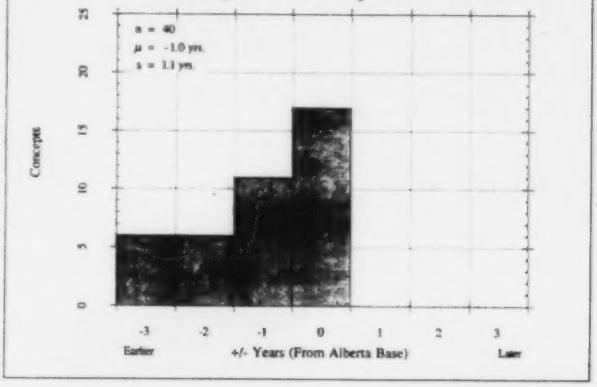


Figure 15:
German Physics Concept Introduction
40 Sample with Depth Modifiers



C. Text Format

A complete set of texts was available from the comparison countries for each of the study subjects.

Japanese texts are student-owned inexpensive paperbacks. Math texts are terse and contain little information extraneous to a concise presentation of the concept, and only a few exercise problems are included. Science texts are similar in style but contain more colourful illustrations. The texts appear to be more of a concept register and clearly require teacher and student participation in addition to the text for learning to take place.

In contrast, Alberta texts are much thicker, clearly more expensive, and more colourful. They often include considerable material extraneous to the basic concept, more teaching examples and more practice problems than Japan. The Alberta text style seems to attempt to contain sufficient materials to teach the subject without teacher intervention.

Alberta physics and chemistry texts were effectively non-existent; the physics textbook was out of print and obsolete. A chemistry text was in the process of selection; inexpensive and relatively sparsely illustrated booklets (the Alchem Series) have been in use for years.

German texts were closer in style to Albertan materials, but were considerably more concise and compact. They generally

appear more sophisticated in their illustrations and concept presentation, with few of the cartoons found in Alberta texts.

Hungarian text books are more similar to the Japanese materials. Earlier introduction of science is very noticeable. The grade seven chemistry text, on a cursory examination, contains many of the same topics introduced several years later in Alberta (see Appendix 3).

D. Streaming

This study concentrated on common curriculum until grade 9 or ten, depending on the country and the academic stream thereafter. Hungary streams after grade eight, Alberta after grade nine, Japan after grade 10.

The state of Hesse in Germany was chosen for comparison; there, all students (except about 19% of students who proceed to a vocational school after grade 9) take a common curriculum in math, physics and chemistry from grade 7 through grade 10, although they may attend a variety of school types.

Thus, in the jurisdictions examined, the majority of students were exposed to a common curricula through grade nine or 10.

It was not practical to examine the curricula of the vocation streams because of the variety of the schools and curricula.

The following data portrays the portion of students in each stream at the upper secondary level in Japan, Germany (West), Hungary and Alberta, and should be considered as approximate only. Besides being dated, it is also clouded by participation rates in education. The Alberta participation rate in formal education among 17-year-olds is 66% versus 94% in Japan, 89% in Germany, and about 90% in Hungary.

Japan (1984, post grade 10)
Academic: 72%
Vocational: 28%

Germany (West) (1987, post grade 10) [2]
Academic: 20%
Vocational full-time: 23%
Vocational part-time: 57%

Hungary (1980, post grade 8)
Academic: 22%
Technical: 28%
Vocational: 50%

Alberta does not have a similar demarcation between academic and vocational streams. Rather, it offers two levels of high school diploma: General and Advanced (more demanding in math and science).

Alberta (1987/88)
Advanced Diploma: 56%
General Diploma: 44%

IV. Discussion

In general, topics in mathematics, physics and chemistry were found to be introduced earlier in the comparison countries. This is more apparent after depth of treatment is considered. In this regard, Japan was found to be the most similar of the three countries to Alberta. It can only be concluded that if international achievement tests are legitimate measures, then the typically superior performance of Japan does not lie in a dramatically different curriculum. Probably, it lies in superior education practices and perhaps cultural differences.

The dramatically earlier introduction of physics and chemistry in Germany and Hungary appears to complement those countries' high regard for good vocational and technical training. By the time students enter vocational training, they should be well-grounded in math and science.

The lesson for Alberta is that curriculum designers should not underestimate the ability of students to take more math and science earlier, and should seek to learn from other countries. It would be useful to determine in detail what materials students actually master with earlier introduction through examination of

"...Alberta texts are much thicker, clearly more expensive, and more colourful. They often include considerable material extraneous to the basic concept..."

"(German texts) generally appear more sophisticated in their illustrations and concept presentation, with few of the cartoons found in Alberta texts."

test materials. As well, the sequence and timing of curriculum components could be explored.

The majority of students world-wide do not take post-secondary education. In Alberta, after accounting for the participation rate in formal education, about two-thirds of students do not proceed to post-secondary institutes.

It appears that improving the quality of education to these Alberta non-post-secondary students would be of great benefit. Examination of the vocational systems, particularly those of European countries, is highly recommended along with an examination of their school-to-work transitions.

The repetition in the Alberta junior high mathematics texts is undesirable. It can only lead to confused accountability for imparting a concept, and undoubtedly leads to student boredom. It may also lead to a culture where repetition rather than mastery is expected.

The difference in the appearance and style of the texts in the respective countries was also illuminating. Japan does not rely on lavish books to achieve academic excellence. It is probable that Alberta expenditure on texts is out of proportion to the teaching value received. Ironically, the Alberta chemistry booklets soon to be replaced with a more typical text book are sparser and less expensive than the Japanese texts.

As a final note, there are indeed some concerns with the Alberta curriculum, and some areas identified for improvement. However, it should also be noted that the Alberta curriculum is already very comprehensive. It is not only what is in the curriculum that is important, but the extent and the quality to which the curriculum is conveyed. That students in other countries are mastering more math and science earlier or to a higher level is a sign of other more fundamental aspects of the respective education systems and cultural differences.

Footnotes

[1] Wolfgang Mitter, "Secondary Education in the Federal Republic of Germany," in Changing Patterns of Secondary Education: An International Comparison, (Calgary: University of Calgary Press, 1987), pp. 101-02.

[2] Harold W. Stevenson and Karen Bartsch, "An Analysis of Japanese and American Textbooks in Mathematics," Diss (Ann Arbor: University of Michigan, 1985).

Appendix 1: Textbooks Consulted

Alberta

Journeys in Math 7, Ginn Publishing Canada Inc., 1987
Journeys in Math 8, Ginn Publishing Canada Inc., 1987
Journeys in Math 9, Ginn & Company, 1988
Mathematics 10, Addison-Wesley Publishers Ltd., 1987
Mathematics 11 (National Edition), Addison-Wesley Publishers Ltd., 1990
Mathematics 12 (National Edition), Addison-Wesley Publishers Ltd., 1991
Math 31 (excluding Chapters 12, 16, 17, 18), Holt, Rinehart and Winston of Canada Ltd., 1984

Science Directions 7, John Wiley & Sons, 1988
Science Directions 8, John Wiley & Sons, 1991
Science Directions 9, John Wiley & Sons, 1991
Visions (Science 10), Gage Ed. Pub. Co., 1991
Merrill Physics, Macmillan/McGraw-Hill, 1992

Germany

Mathematik 7, Westermann, 1988
Mathematik 8, Westermann, 1989
Mathematik 9, Westermann, 1990
Mathematik 10, Westermann, 1990
Einfuhrung in die Analysis 1, Schroedel-Schonigh, 1988
Einfuhrung in die Analysis 2, Schroedel-Schoningh, 1990
Grundkurs Stochastik, Schroedel-Schoningh, 1990
Lineare Algebre/Analytische Geometrie, Schroedel-Schoningh, 1986
Leistungskurs Stochastik, Schroedel-Schoningh, 1984

Kuhn Physik Band I, Westermann, 1990
Kuhn Physik Band II, Westermann, 1989
CVK Physik 7-10, Cornelson, 1990
Dorn-Bader Physik 12/13 Schroedel, 1986

Japan

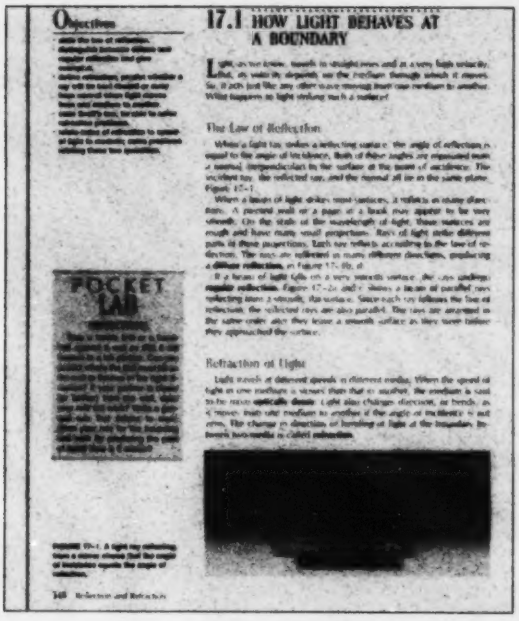
Mathematics (Grade 7), Keirinkan, 1989
Mathematics (Grade 8), Keirinkan, 1989
Mathematics (Grade 9), Keirinkan, 1989
Mathematics I (Grade 10), Keirinkan, 1987
Mathematics II (Grade 11), Keirinkan, 1988
Differential/Integral Calculus, Keirinkan, 1988 (Grade 12)
Basic Analysis (Grade 12), Keirinkan, 1989

Physics and Chemistry (Grades 7 & 8), Keirinkan, 1989
Physics and Chemistry (Grades 8 & 9), Keirinkan, 1989
General Science (Grade 10), Keirinkan, 1990
Physics (Grades 11 & 12), Kierinkan, 1988
Chemistry (Grades 11 & 12), Kierinkan, 1985

Appendix 2(a)

Physics: ***Different Grades***
Similar Depth of Treatment

Alberta Grade 11: (Merrill Physics, McMillan/McGraw Hill, 1992)

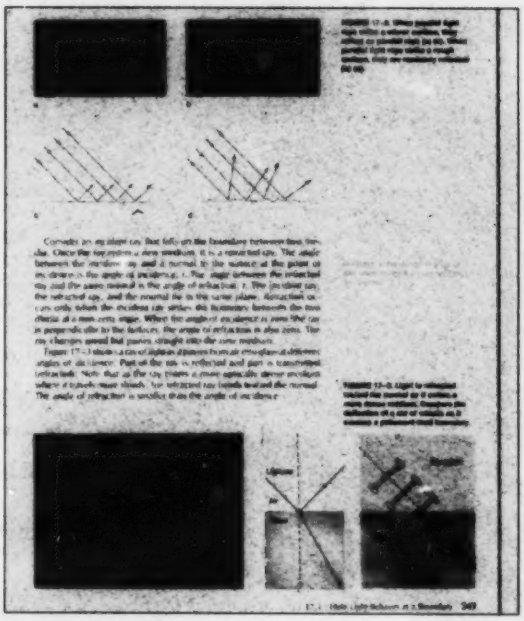


17.1 HOW LIGHT BEHAVES AT A BOUNDARY

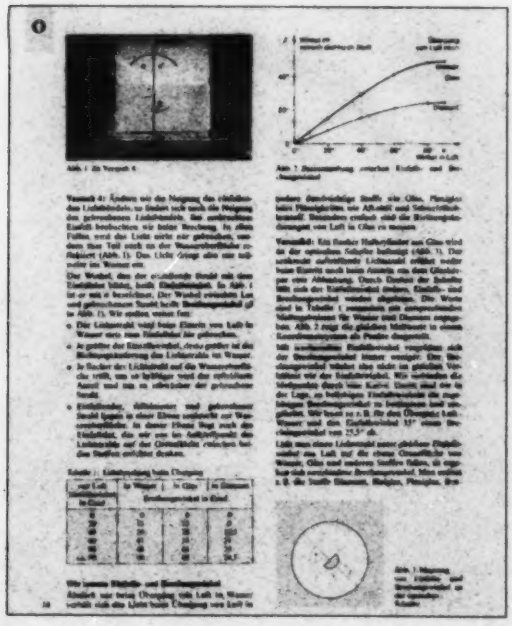
The Law of Reflection

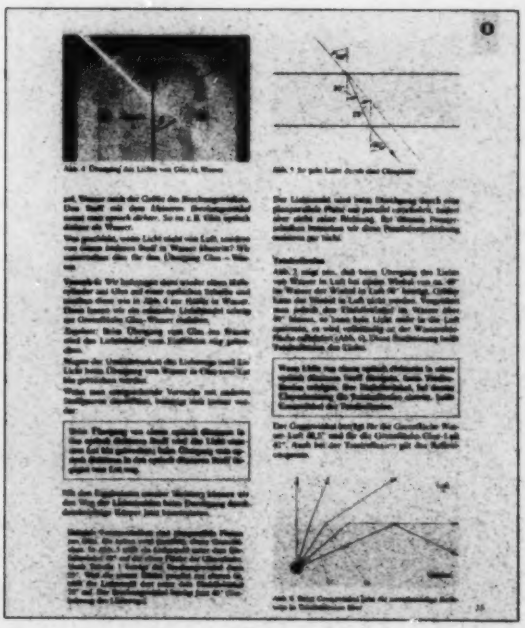
Refraction of Light

POCKET LAB



Germany Grade 7: (Kuhn Physik Band I, Westermann, 1990)

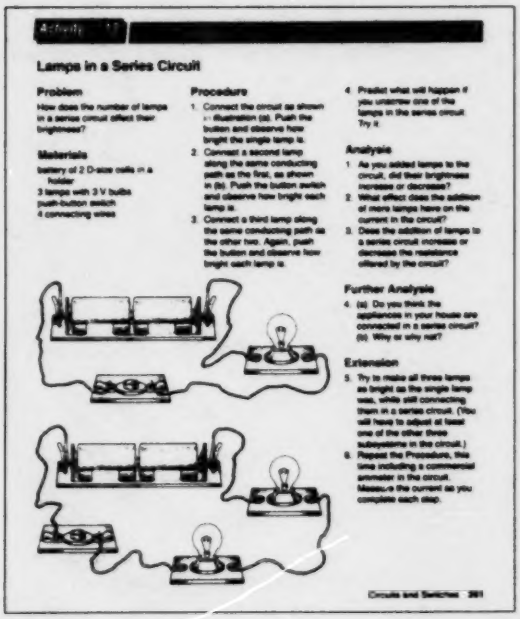




Appendix 2(b)

Physics: ***Same Grades***
Different Depth of Treatment

Alberta Grade 9: (Science Directions 9, John Wiley & Sons, 1991)



Activity 1

Lamps in a Series Circuit

Problem

How does the number of lamps in a series circuit affect their brightness?

Materials

battery of 2 D-size cells in a holder
3 lamps with 3 V bulbs
push-button switch
4 connecting wires

Procedure

1. Connect the circuit as shown in illustration (a). Push the button and observe how bright the single lamp is.
2. Connect a second lamp along the same conducting path as the first, as shown in (b). Push the button switch and observe how bright each lamp is.
3. Connect a third lamp along the same conducting path as the other two. Again, push the button and observe how bright each lamp is.
4. Predict what will happen if you unscrew one of the lamps in the series circuit. Try it.

Analysis

1. As you added lamps to the circuit, did their brightness increase or decrease?
2. What effect does the addition of more lamps have on the current in the circuit?
3. Does the addition of lamps to a series circuit increase or decrease the resistance offered by the circuit?

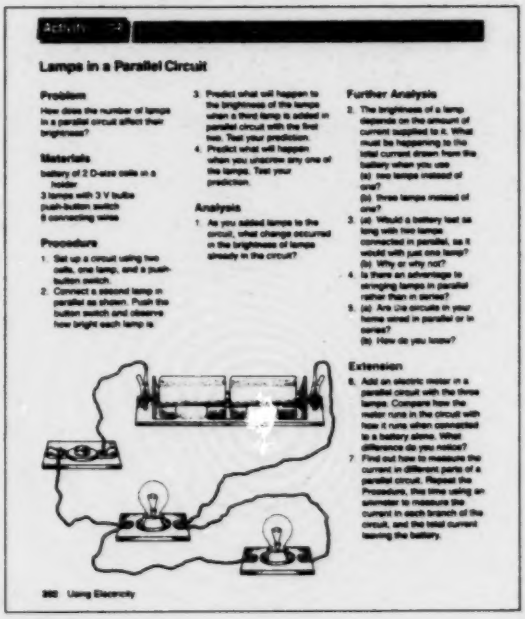
Further Analysis

4. (a) Do you think the appliances in your house are connected in a series circuit?
   (b) Why or why not?

Extension

5. Try to make all three lamps as bright as the single lamp was, while still connecting them in a series circuit. (You will have to adjust at least one of the other three bulbs/lamps in the circuit.)
6. Repeat the Procedure, this time including a commercial ammeter in the circuit. Measure the current as you complete each step.

Circuits and Switches 361



Activity 2

Lamps in a Parallel Circuit

Problem

How does the number of lamps in a parallel circuit affect their brightness?

Materials

battery of 2 D-size cells in a holder
3 lamps with 3 V bulbs
push-button switch
6 connecting wires

Procedure

1. Set up a circuit using two cells, one lamp, and a push-button switch.
2. Connect a second lamp in parallel as shown. Push the button switch and observe how bright each lamp is.
3. Predict what will happen to the brightness of the lamps when a third lamp is added in parallel circuit with the first two. Test your prediction.
4. Predict what will happen when you unscrew any one of the lamps. Test your prediction.

Analysis

1. As you added lamps to the circuit, what change occurred in the brightness of lamps already in the circuit?

Further Analysis

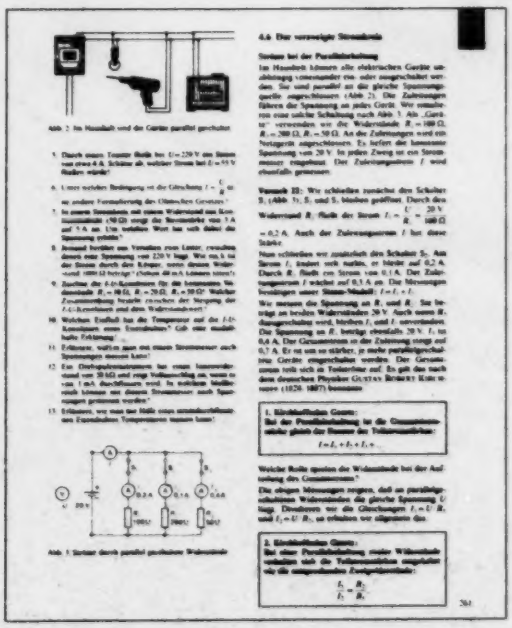
2. The brightness of a lamp depends on the amount of current supplied to it. What must be happening to the total current drawn from the battery when you use
   (a) two lamps instead of one?
   (b) three lamps instead of one?
3. (a) Would a battery last as long with two lamps connected in parallel, as it would with just one lamp?
   (b) Why or why not?
4. Is there an advantage to arranging lamps in parallel rather than in series?
5. (a) Are the circuits in your home wired in parallel or in series?
   (b) How do you know?

Extension

6. Add an electric meter in a parallel circuit with the three lamps. Compare how the meter runs in the circuit with how it runs when connected to a battery alone. What difference do you notice?
7. Find out how to measure the current in different parts of a parallel circuit. Repeat the Procedure, this time using an ammeter to measure the current in each branch of the circuit, and the total current leaving the battery.

362 Using Electricity

Germany Grade 9: (Kuhn Physik Band I, Westermann, 1990)



4.6 Die verzweigte Stromkreis

Serien bei der Parallelschaltung

Im Haushalt können alle elektrischen Geräte unabhängig voneinander ein- oder ausgeschaltet werden. Sie sind parallel an die gleiche Spannungsquelle angeschlossen (Abb. 2). Der Zuleitungen führen die Spannung an jedes Gerät. Wir untersuchen eine solche Schaltung nach Abb. 1. Als „Geräte" verwenden wir die Widerstände $R_1 = 100\,\Omega$, $R_2 = 200\,\Omega$, $R_3 = 50\,\Omega$. An die Zuleitungen wird ein Netzgerät angeschlossen. Es liefert eine konstante Spannung von 20 V. In jeden Zweig ist ein Strommesser eingebaut. Der Zuleitungsstrom I wird ebenfalls gemessen.

Versuch 25: Wir schließen zunächst den Schalter S_1 (Abb. 1), S_2 und S_3 bleiben geöffnet. Durch den Widerstand R_1 fließt der Strom $I_1 = \frac{U}{R_1} = \frac{20\ \text{V}}{100\,\Omega} = 0{,}2\ \text{A}$. Auch der Zuleitungsstrom I hat diese Stärke.

Nun schließen wir zusätzlich den Schalter S_2. Am Strom I_1 ändert sich nichts, er bleibt auf 0,2 A. Durch R_2 fließt ein Strom von 0,1 A. Der Zuleitungsstrom I wächst auf 0,3 A an. Die Messungen bestätigen unsere Stoß-Modell: $I = I_1 + I_2$.

Wir messen die Spannung an R_1 und R_2. Sie beträgt an beiden Widerständen 20 V. Auch wenn R_2 ausgeschaltet wird, bleiben I_1 und I_2 unverändert. Die Spannung an R_1 beträgt ebenfalls 20 V. I_1 ist 0,4 A. Der Gesamtstrom in der Zuleitung steigt auf 0,7 A. Er ist um so stärker, je mehr parallelgeschaltete Geräte eingeschaltet werden. Der Gesamtstrom teilt sich in Teilströme auf. Es gilt das nach dem deutschen Physiker GUSTAV ROBERT KIRCHHOFF (1824–1887) benannte

1. Kirchhoffsches Gesetz:
Bei der Parallelschaltung ist die Gesamtstärke gleich der Summe der Teilstromstärken:

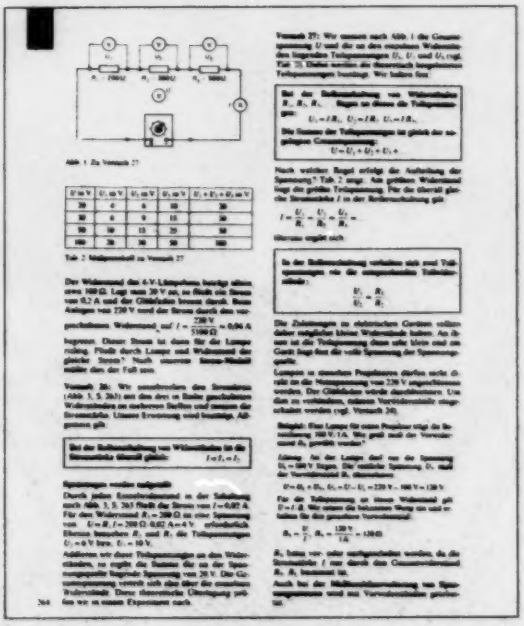
$$I = I_1 + I_2 + I_3 + \dots$$

Welche Rolle spielen die Widerstände bei der Aufteilung des Gesamtstromes?

Die obigen Messungen zeigen, daß an parallelgeschalteten Widerständen die gleiche Spannung U liegt. Daraufhin wir die Gleichungen $I_1 = U/R_1$ und $I_2 = U/R_2$ an erhalten wir allgemein die

2. Kirchhoffsches Gesetz:
Bei einer Parallelschaltung zweier Widerstände verhalten sich die Teilspannungsstärken umgekehrt wie die entsprechenden Zweigwiderstände:

$$\frac{I_1}{I_2} = \frac{R_2}{R_1}$$



Versuch 27: Wir messen nach Abb. 1 die Gesamtspannung U und die an den einzelnen Widerständen liegenden Teilspannungen U_1, U_2 und U_3 (vgl. Tab. 2). Dabei werden die theoretisch berechneten Teilspannungen bestätigt. Wir halten fest

Für eine Reihenschaltung von Widerständen R_1, R_2, R_3, ... liegen an diesen die Teilspannungen
$U_1 = I \cdot R_1$, $U_2 = I \cdot R_2$, $U_3 = I \cdot R_3$, ...
Die Summe der Teilspannungen ist gleich der angelegten Gesamtspannung:
$U = U_1 + U_2 + U_3 + \dots$

Nach welcher Regel erfolgt die Aufteilung der Spannung? Tab. 2 zeigt: Am größten Widerstand liegt die größte Teilspannung. Für die überall gleiche Stromstärke I in der Reihenschaltung gilt

$$I = \frac{U_1}{R_1} = \frac{U_2}{R_2} = \frac{U_3}{R_3} = \dots$$

Hieraus ergibt sich

In der Reihenschaltung verhalten sich zwei Teilspannungen wie die entsprechenden Teilwiderstände:

$$\frac{U_1}{U_2} = \frac{R_1}{R_2}$$

Die Zuleitungen zu elektrischen Geräten sollen dicker sein als dünne Widerstände haben. An dicken sei die Teilspannung dann sehr klein und am Gerät liegt fast die volle Spannung der Spannungsquelle.

Lampen in einzelnen Projektoren dürfen nicht direkt an die Netzspannung von 220 V angeschlossen werden. Der Glühfaden würde durchbrennen. Um dies zu verhindern, müssen Vorwiderstände eingeschaltet werden (vgl. Versuch 24).

Beispiel: Eine Lampe für einen Projektor trägt die Aufschrift 100 V 1 A. Wie groß muß der Vorwiderstand R_V gewählt werden?

Lösung: An der Lampe darf nur die Spannung $U_1 = 100$ V liegen. Die restliche Spannung U_V muß der Vorwiderstand R_V übernehmen:

$U = U_1 + U_V$; $U_V = U - U_1 = 220\ \text{V} - 100\ \text{V} = 120\ \text{V}$.

Für die Teilspannung an einem Widerstand gilt $U = I \cdot R$. Wir setzen die bekannten Werte ein und erhalten für den gesuchten Vorwiderstand:

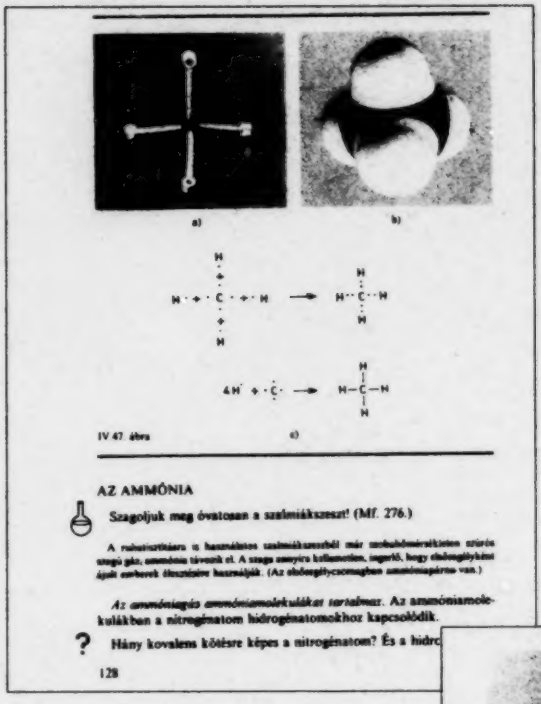
$R_V = \frac{U_V}{I} = \frac{120\ \text{V}}{1\ \text{A}} = 120\,\Omega$.

R_V kann von außen eingeschaltet werden, da die Stromstärke I nur durch den Gesamtwiderstand $R_1 + R_V$ bestimmt ist.

Auch bei der Hintereinanderschaltung von Spannungsquellen wird auf Vorwiderstände geachtet.

Appendix 2(c): Hungarian Chemistry Grade 7

(Kemia 7, 1990)



IV.47. ábra

AZ AMMÓNIA

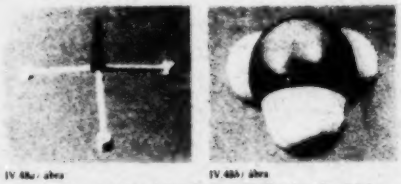
Szagoljuk meg óvatosan a szalmiákszeszt! (Mf. 276.)

A raktárakban a használatos szalmiákszeszből már szobahőmérsékleten szúrós szagú gáz, ammónia távozik el. A szag anyira kellemetlen, ingerlő, hogy elsősegélyként újult eszmélet élesztésére használják. (Az elsősegélycsomagban ammóniaspárga van.)

Az ammóniagáz ammóniamolekulákat tartalmaz. Az ammóniamolekulákban a nitrogénatom hidrogénatomokhoz kapcsolódik.

? Hány kovalens kötésre képes a nitrogénatom? És a hidro

128



IV.48a. ábra IV.48b. ábra

A nitrogénatom három hidrogénatommal alkot kovalens kötést:

$$3\,H\cdot + \cdot\ddot{N}\cdot \longrightarrow H:\underset{\displaystyle H}{\overset{\displaystyle \cdot\cdot}{N}}:H$$

Az ammóniamolekula összegképlete: NH_3 *(IV.48a) és b) ábra)* A képletből az összekapcsolódó atomok minőségét és számát egyaránt leolvashatjuk. Ennek segítségével megállapíthatjuk, hogy *1 mol ammónia tömege:* 14 g + 3 · 1 g = 17 g.

Az ammónia gyári előállítása a levegő nitrogénjéből és a földgáz (esetleg a víz) hidrogénjéből történik.

$N_2 + H_2 \rightarrow NH_3$

Használnunk ennie a kiindulási és a keletkezett anyagok képletét! Minden kétatomos nitrogénmolekulából két ammóniamolekula képződhet:

$N_2 + H_2 \rightarrow 2\,NH_3$

2 mol ammóniamolekulában összesen 6 mol hidrogénatom van kovalens kötésben. 2 mol ammónia keletkezéséhez 3 mol hidrogénmolekula kötését kell lerontanunk:

$N_2 + 3\,H_2 \rightarrow 2\,NH_3$

A nitrogén (N_2) és a hidrogén (H_2) egyesülésének a folyamata végeredményben: *(IV.49. ábra)*

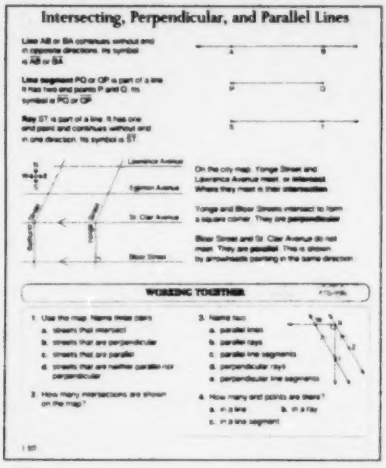
$3\,H_2 + N_2 \longrightarrow 2\,NH_3$

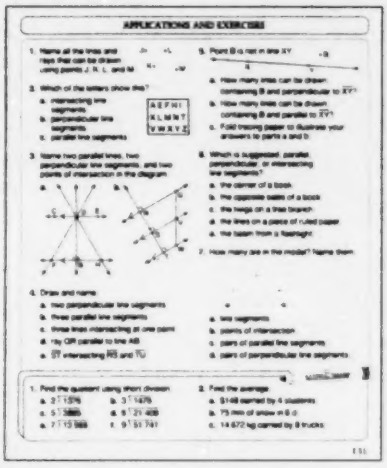
IV.49. ábra

129

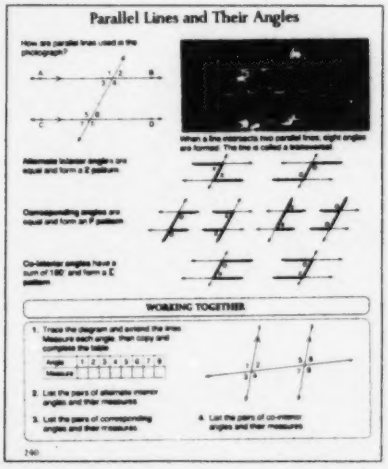
Appendix 3: Alberta Math Concept Repetition

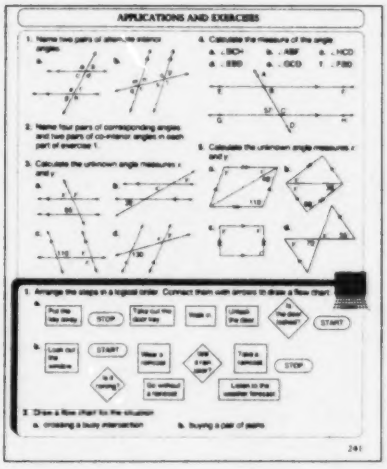
Grade 7 (Journeys in Math 7, Ginn Pub. Can. Inc., 1987)


Intersecting, Perpendicular, and Parallel Lines

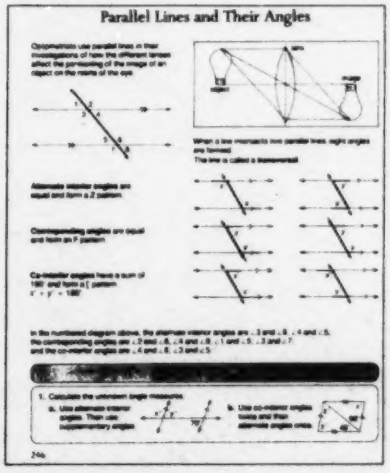

APPLICATIONS AND EXERCISES

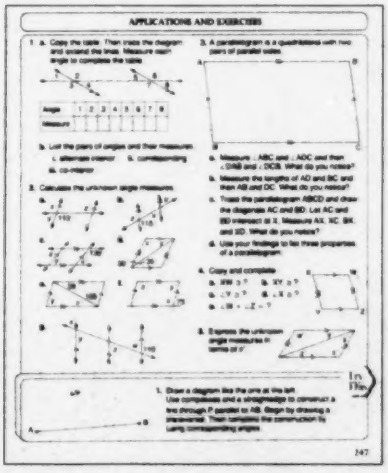
Grade 8 (Journeys in Math 8, Ginn Pub. Can. Inc., 1987)


Parallel Lines and Their Angles


APPLICATIONS AND EXERCISES

Grade 9 (Journeys in Math 9, Ginn Pub. Can. Inc., 1988)


Parallel Lines and Their Angles


APPLICATIONS AND EXERCISES

Report 2:

Alternative Values, Schools, and Futures for the 21st Century

A paper prepared by Robert S. Patterson, Professor of Education, University of Alberta, and former Dean of the Faculty of Education, University of Alberta, for the ACR International Comparison study.

Research Assistant for the paper was Michael R. Patterson.

I. Introduction

"Urgent." "Vital." "Essential."

These words have long characterized the language of Albertans urging educational reform, particularly those who wish to see significant change in the province's mathematics and science curricula.

Unfortunately, such calls for immediate action have been made for so many years that their impact has been dulled, and many government and professional leaders have lost interest. Ironically, the task of raising public consciousness is now more difficult than it would have been if Albertans were hearing the message for the first time.

Part of the challenge before this province is to act upon the situation immediately — valuable time has been lost.

II. A Persistent Problem

In 1979, the Science Council of Canada undertook an intensive four-year study of the country's science education curricula. Its recommendations were generally progressive and upbeat: increase the participation of young women in science education, challenge high science achievers, introduce technology education, ensure quality in science education and guarantee it in every elementary school, present a more authentic view of science with emphasis on the essential science/technology/society connection, and set science education in a Canadian context.

In its conclusion, however, the study's tone was somewhat more dramatic: "Any delay in renewing our science education systems threatens Canada's capacity to participate in a changing world..."[1]

International studies confirm the warning. The International Association for the Evaluation of Educational Achievement (IEA) placed Canada's educational system in a world context, and concluded that our students have not performed among the more highly achieving participants — and, moreover, that we have legitimate cause for concern and action.

III. Contemporary Concern

Today, concern over student achievement in mathematics and science in this province is being expressed by a variety of prominent individuals and groups.

Alberta Minister of Education J. Dinning has spoken several times on Alberta's education goals

Figure 1:
Per Student Expenditure by Province
1985/86 and 1988/89

Province	1985/86	Rank	1988/89	Rank
British Columbia	$ 3,537	(6)	$ 4,455	(8)
Alberta	$ 4,085	(2)	$ 4,946	(4)
Saskatchewan	$ 3,678	(5)	$ 4,655	(6)
Manitoba	$ 3,873	(4)	$ 5,196	(3)
Ontario	$ 4,074	(3)	$ 5,305	(2)
Quebec	$ 4,714	(1)	$ 5,894	(1)
New Brunswick	$ 3,160	(8)	$ 4,657	(5)
Nova Scotia	$ 3,323	(7)	$ 4,610	(7)
Prince Edward Island	$ 2,711	(10)	$ 4,025	(9)
Newfoundland	$ 2,883	(9)	$ 4,008	(10)
United States	US $ 3,756 - 1986		US $3,977 (May 1989)	

"For at least a decade, voices in Canada and across the United States have been raised in an effort to sensitize North Americans to the prospect of declining productivity, prosperity and prominence in the face of unaltered and unimproved participation trends and achievement results in mathematics and science."

for the coming decade, stressing that we must re-examine the way science and mathematics are taught in this province: "Our students must understand the fundamentals of science. But they must know that science does not exist just in the independent boxes of biology, physics, and chemistry... They must know about the interrelationship of all three."[2]

The Science Alberta Foundation has launched a public awareness campaign of its own, commenting that "tomorrow's tools will be science and technology, and the products of these tools will be economic growth."[3] Despite this prediction, the Foundation notes that less than 20% of the province's high school students are 'very interested' in science.[4]

IV. Insights From Our Past

In 1972, Dr. W.H. Worth presented Albertans with two alternative education scenarios in a report for the Commission for Educational Planning. *A Choice of Futures* suggested that the province's first option — for a "second-phase industrial society" — was to emphasize self-control, self-discipline, conformity, puritanism, a willingness to endure stress, and an interest in acquisition. The second — or "person-centred" — option stressed qualities of self-discovery, individualism, sensual indulgence, pursuit of personal happiness, and self-fulfillment.

In the twenty years following the publication of this report, Albertans and most North Americans have increasingly drifted in the direction of the individualistic, highly indulgent, pluralistic, and equality-oriented society. As a result, resistance has built up against the operation of a more competitive, rigorous educational program with higher achievement standards for all students.

How can we reconcile the conflicting values of our divided citizenry? Teachers face this question on a daily basis, and know better than anyone that our fluctuations between the industrial society and person-centred options result in a difficult double standard.

For example, teachers today see a certain number of children eager to learn, responsive to teacher direction, and willing to pursue achievement objectives. These young students are generally supported by parents who encourage academic efforts.

However, as these values increasingly erode, teachers in Alberta are faced with problems of student indifference, disobedience, illness, emotional instability, and unfavorable work habits. As attention is directed more and more to these conditions, school personnel find it difficult to direct students to academic achievement and skill mastery.

V. Prevailing Social Conditions and Values

There are a number of prime contributors to Alberta's academic predicament.

Parental attitudes are key. Many parents encourage their school-aged children to earn expense or living money in part-time jobs, discourage homework and study time as an undesirable encroachment on their childrens' time — in short, believe that children are 'only young once', and deserve the freedom to pursue their own interests.

Peer influence also has an enormous effect upon the attitudes of children and teenagers. Today's youth culture subverts academic achievement in favour of conformity to the consumer-oriented images of our mass culture. Television, videos, and popular music supports this subversion and further occupy a large percentage of time for school-aged children.

In fact, a study by the Canadian Youth Foundation in 1987 reported that 67% of young people aged 15 to 24 watched television two hours or more daily[5]; at the same time, approximately 55% of this same age group in Canada's prairie region worked either full- or part-time.[6]

Changing family conditions are also having a detrimental effect on educational standards. Today, although people in this province constitute only 9% of the country's population, Albertans account for 21% of all Canadian divorces and occupy the number-one position for divorces in Canada.[7] Further, Alberta Education estimates that in this province "54% of all children live in a two-parent family where both parents work, and 70% of single-parent children live in a family where the parent works, leading to as many as 36,000 'latchkey' children 12 years and under."[8] In addition, 1986 statistics show that approximately 15% of Alberta children aged 16 and under lived in families below the poverty line.[9]

Today, the Alberta population looks increasingly to the school system to cure its range of societal ills. Today, our schools are asked to mainstream children with lower mental abilities and various disabilities, and to encourage tolerance and respect for people of differing races, conditions, languages, religions, and cultures.

While these values are undoubtedly positive ones, they tend to slow down the usual academic processes. In 1985, it was estimated that roughly 50% of all Alberta immigrants could not speak one of our official languages.[10] The presence of these students means that teachers and other students must direct more time and effort toward making these young people welcome members of the community.

Another form of educational inefficiency in Alberta is demonstrated by the number of students repeating Grade 12 in order to raise their academic average for admission to college and university. According to Alberta Education, "the percentage of Grade 12 students older than 17 has increased from 14.6 per cent in 1977/78 to 27.2 per cent in 1987/88."[11]

At the same time, the high school dropout rate in this country has reached alarming proportions. In response to this situation, Employment and Immigration Canada has launched "Stay At School", a $296 million, five-year plan to counteract the drop-out rate. Two viewpoints have arisen as a result: the first comments on the dropout problem by favoring a more varied and stimulating program with quality instruction; the second claims the need for a narrower, more challenging core of

"The *Science Alberta Foundation* has also spoken out on the need for Albertans to 'create an increasingly science-literate society.' It points out that 'tomorrow's tools will be science and technology, and the products of these tools will be economic growth.' "

Figure 2:
Number of Students Writing Diploma Examinations,
1984-85 to 1988-89

Course	*1984/85*	*% of Total Grade 12 Enrollment*	*1985/86*	*% of Total Grade 12 Enrollment*	*1986/87*	*% of Total Grade 12 Enrollment*	*1987/88*	*% of Total Grade 12 Enrollment*	*1988/89*	*% of Total Grade 12 Enrollment*
English 30	20,548	54.6	21,819	58.3	22,823	59.1	23,308	58.6	23,805	60.3
English 33	10,534	28.0	10,480	29.0	9,934	25.7	9,860	24.8	9,376	23.8
Social Studies 30	17,593	46.8	19,073	50.8	19,269	49.9	20,628	51.8	20,620	52.2
Mathematics 30	17,425	46.3	18,907	50.6	18,872	48.8	19,564	49.2	19,669	49.8
Biology 30	14,315	38.1	16,004	42.8	17,750	45.9	18,752	47.1	18,791	47.6
Chemistry 30	14,160	37.6	15,270	40.8	15,560	40.3	16,133	40.5	16,297	41.3
Physics 30	8,005	21.3	8,141	21.8	8,418	21.8	8,698	21.9	8,149	20.6
TOTAL	**102,580**		**109,694**		**112,626**		**116,943**		**116,707**	

"The wonders of science cannot be the preserve of the chosen few."
Hon. J. Dinning, Alberta Minister of Education

studies.

The latter viewpoint is supported by recent figures which show that among Grade 12 diploma students, roughly 50 per cent wrote the final exam in Math 30, 41 per cent in Chemistry 30, and only 21 per cent in Physics 30.[12] This low selection is reason for some to advocate science and math courses as mandatory for more of the student body.

VI. Cross-Cultural Comparisons

Perhaps no contemporary educational system has generated more external investigation than that of the Japanese. In his 1989 study of Japan's educational thought, Stephen Platzer notes that, based upon intensive studies of the Japanese school system, informed westerners increasingly believe that until "children are able to match the levels of academic excellence already reached by the youth of Japan, there is no simple way to compete economically against the Japanese."[13]

A number of conditions characterize the Japanese educational system:

1. The role played by the Japanese family, especially by the mother, is central to the child's success at school. Families make considerable sacrifice to maximize their child's success; in turn, the child studies earnestly with the desire to bring honor to the family.

2. Compulsory schooling in Japan begins at age six and extends for nine years, with six years of elementary school and three of lower-secondary school. During these years, there is no ability grouping, tracking, or provision of electives in the curriculum, while a sound mastery of mathematics is absolutely required. Children with major disabilities are educated in special schools.

3. Although it is an extra expense, pre-school education is heavily attended, with approximately 40 per cent of all three-year-olds and 92 per cent of all four- and five-year-olds attending.[14] The curriculum focuses on development of social skills and familiarization with school life.

4. Children seeking admission to upper secondary school must make formal application to do so, and must perform satisfactorily on an entrance examination. The results of these examinations are critical determinants of which senior high school a child may attend and, ultimately, because of the quality of the high school, which college or university may be open to the student. A similar screening process is made with the transition from high school to university or college.

Figure 3:
Comparison of the Number of Grade Nine Students (by year) with the Number of Grade 12 Students Three Years Later

"A"		"B"		
Grade 9 Enrollment as of September 30th		*Grade 12 Enrollment Three Years Later*		*Percent*
(Year)	*Enrollment*	*(Year)*	*Enrollment*	*B/A*
1975	36,532	1978	32,124	87.9
1976	37,093	1979	32,267	87.0
1977	37,620	1980	32,725	87.0
1978	37,471	1981	33,558	89.6
1979	34,516	1982	32,964	95.5
1980	33,172	1983	34,163	103.0
1981	33,001	1984	35,618	107.9
1982	33,120	1985	35,401	106.8
1983	33,332	1986	36,489	109.5
1984	33,423	1987	37,646	112.6

5. The competition and pressure to excel academically in Japan is so intense that private schools have been established to provide remedial instruction. These "cram" schools are an extra expense, and children of the well-to-do and professional classes tend to be advantaged by their existence.

6. Public costs for education in Japan are lower than in other countries included in this study. School facilities are merely functional, textbooks inexpensive, school libraries poorly stocked and Japanese children assist with the custodial care of the school, thereby lowering upkeep costs and learning important values. Teachers, however, are well paid.

7. Virtually all children (99 per cent plus) in Japan complete their compulsory education. An egalitarian philosophy predominates, with children promoted automatically from grade to grade, thus minimizing the occurrence of dropouts.

8. Almost 40 per cent of Japanese students participate in higher education, either in universities or colleges.[15] Colleges exist for general education or technical training purposes only, while universities are informally ranked according to status and prestige factors, and play a significant part in the eventual job placement received by a student. Because the workplace is dominated by men, and because Japanese culture stresses the role of women in child-rearing, the numbers of women entering university drop dramatically.

While the advantages of the Japanese schooling system are readily apparent, the disadvantages should also be noted. Educational experts suggest that the growth of socially unacceptable forms of behaviour can be attributed to the competition bred by exam pressures, including a perceived lack of general critical ability outside the parameters of entrance examinations.

Reformers within the Japanese system suggest that their children are not truly free to pursue their own academic ends, and that Japan's school system should be reorganized so that parents, teachers, and administrators may not violate a child's educational rights.

Ironically, while many North Americans are looking to Japan for academic guidance, the Japanese are considering the American system for reformation purposes. The Japanese Educational Reform Council argues that it is important to "restore in the world of education vitality and creativity, enriched humanity and heart-to-heart contact among people, while paying attention to the current pathological phenomena"[16] existing in their educational system.

If Albertans then believe the Japanese are leaders in education, we should also carefully consider their current push for reform. A few points of comparison may throw light on the situation:

1. The debate over education in both societies reveals the fact that neither system holds the ideal solution. The emphasis upon creative and independent thinking in the Alberta educational system may in many cases be considered a positive strength.

2. A new emphasis upon mathematics and science should not eclipse this same creativity and independence, nor should educational reform be limited to a select population with either the money or disposition to act.

3. Educational models for the future should concentrate upon skills related to accessing and using information, problem identification and solving, and should balance these skills with the knowledge basics and skill mastery in our current educational system.

Like Japan, the European countries of France, Germany, and Hungary graduate students with higher achievement scores in mathematics and science subjects than their counterparts in Alberta, as well as a larger supply of graduates who pursue careers in science and technological fields. The following points distinguish the systems of these countries:

1. These European examples are distinguished from both Alberta and

"...Germany, Hungary, and France, like Japan, demonstrate a capacity to graduate students with higher achievement scores in mathematics and science subjects than their counterparts in Alberta."

"Schools can be different, and schooling can make a difference."

Japan by their obvious commitment to vocationalism and specific skill training for many of their students. France, Germany, and Hungary identify differing abilities and interests at a relatively early age, and correspondingly direct their students into various streams. Parental preference and teacher advice is also considered in making these decisions. A variety of academic and technical/ vocational schools is available, some of which provide limited transfer from one program route to another.

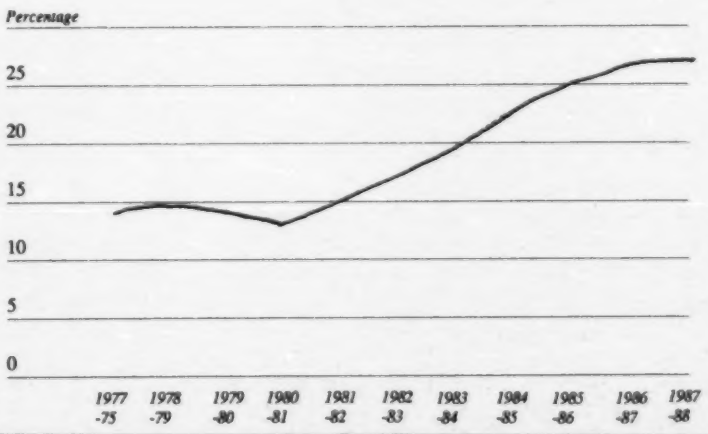
2. Performance standards are critical to grade and school advancement in these countries. It is not uncommon in France and Germany for children to fail and repeat grades at a junior level. The conclusion of secondary education is marked by a standard examination which results in a heavy emphasis upon content knowledge and preparation for these tests.

3. Compulsory schooling in all three countries begins at age six and continues through to age 16. In Hungary and France, nearly all children from ages four to five attend extensive pre-school education. Germany ensures that students completing public education are able to participate effectively in the nation's economy, and students not continuing in formal schooling after age 16 are required to complete three years of part-time vocational education and training. Both Hungary and France are attempting to broaden participation at the secondary school level, and to open university education up to more students.

4. The status of the teaching profession varies considerably among the three countries. Conditions for teaching are most favourable in Germany, where teacher qualifications are higher, and the per centage of males attracted to teaching is also higher. Secondary teachers in all three countries have a strong background in at least two subjects, and teach in these areas, while teachers in elementary schools have at least two to three years of post-secondary education. All teachers in these countries have a comparatively good grounding in mathematics and science. Because some are concerned about the quality of teacher education in Hungary and France, steps are being take to include more pedagogical work and to extend the length of the education program.

5. Mathematics has a central place in the education curriculum of all three countries. Science subjects are somewhat less a priority, although are nonetheless

Figure 4:
Percentage of Grade 12 Students Over the Age of 17



studied by the majority of students.

6. In Germany and Hungary particularly, the preparation of young people for the workplace is an important function of schooling. Hungarian students are provided with special incentives to enter the technical and economic industries, while Germany's attention to quality trades preparation ensures a ready supply of graduates into this sector. More students in these countries are also seeking university entrance, and challenging what has been a selective, biased system with special advantages for the well-to-do and professional classes.

VII. Observations and Recommendations

A. Short-Range Suggestions

The comparison of schooling systems within Japan, Hungary, France, and Germany with Alberta's own educational processes helps identify areas of concern within our province, and recommendations for improvement here.

Those particularly interested in fostering the mathematics and scientific areas in Alberta education might consider the following short-range suggestions:

1. The study of science and mathematics requires more serious attention in our schools, beginning with elementary school and extending throughout public schooling.

RECOMMENDATION #1:
Alter our public school curriculum to ensure a more challenging mathematics and science program is both available and effectively taught beginning in elementary school.

RECOMMENDATION #2:
Require all future teacher education candidates to qualify for university admission by successfully completing high school diploma level mathematics and science coursework.

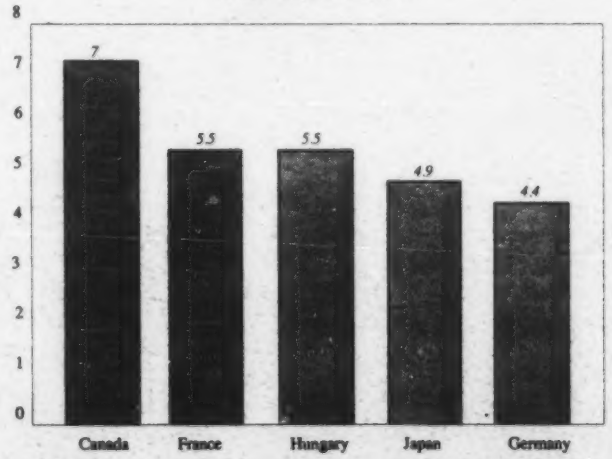
RECOMMENDATION #3:
Support present Alberta Education efforts to provide a general science curriculum for all secondary school students, along with specialized science courses for students majoring in these fields.

RECOMMENDATION #4:
Require secondary-level teachers of mathematics and science to have specialist preparation qualifications in these fields.

RECOMMENDATION #5:
Provide stimulating and innovative in-

"Co-operative learning, lifelong learning, flexibility, openness, creativity, problem solving, self-directed learning, information accessing, and new skill development will characterize our future."

Figure 5:
Public Expenditure on Education as a Percentage of the GNP in 1987



service instruction in mathematics, science, and pedagogy to practising classroom teachers.

2. School graduates should be equipped with a work and performance ethic with greater commitment to high standards of achievement and outcome.

RECOMMENDATION #6:
Create an intensive information campaign designed to promote endorsement of work ethic values. Just as the 'Particpaction' campaign has altered Canadian beliefs about physical fitness, so can a similar campaign change achievement ethics in schools and the workplace.

3. Alberta cannot afford to be a 'house divided' in schooling matters. Partnerships between professional educators, government officials, community members, industry personnel, and students must be positive and progressive.

RECOMMENDATION #7:
Encourage co-ordination of efforts in the mathematics and science fields between the Alberta Teachers' Association, Alberta Education, school district leadership, members of the public, university faculty, and industrial leaders. Specific joint venture projects would build trust between the groups, and would better help students and teachers to understand the role of mathematics and science in Canada's economy.

RECOMMENDATION #8:
Create a number of 'special' elementary and secondary schools where disadvantaged children may learn in stimulating and creative environments. By fostering these schools, it will be possible to show what can be done for students who often opt out of the education system.

RECOMMENDATION #9:
A Centre of Mathematical and Science Instruction should be established in Alberta, with members including professional educators at all levels, industry representatives, government, parents, and public. The Centre would continuously monitor learning and achievement in mathematics and sciences in the province, and would develop the popularity and refinement of these subjects in our society.

B. Long-Range Suggestions

RECOMMENDATION #1:
The 21st Century will see Alberta forming new relationships and boundaries, with information exchange and technology expanding our horizons. The school system must meet the challenges of the coming century with a new emphasis on prerequisite skills, including co-operative, self-directed, and lifelong learning, flexibility, openness, creativity, problem solving, information accessing, and new skill development.

RECOMMENDATION #2:
Schools and teachers must be encouraged simultaneously to change along with pedagogical methods. Partnerships between schools and teacher education institutions should create a learning environment with new research and knowledge, methods and materials — in short, a centre of innovation for all those interested in educational change.

RECOMMENDATION #3:
The above changes must permeate the total educational system. Unless these objectives are pursued at all levels, conflicting values will diminish positive results, and teachers will not properly manage relevant issues of pedagogy.

RECOMMENDATION #4:
Special attention should be made to introducing technological advances in the education system. Simulation, modelling, and gaming strategies may be used to help students gain greater understanding of basic learning techniques.

Footnotes

[1] E. Lawson Drake, Science for Every Student, Report 36 (Ottawa: Science Council of Canada, 1984), p. 11.

[2] The Honourable Jim Dinning, "Address to the Alberta School Trustees' Convention" (Edmonton, AB: November 6, 1990), pp. 7-8.

[3] The Science Foundation of Alberta, "A Science Network for Alberta" (December 1990), p. 5.

[4] Science Foundation, "Science Network", p. 5.

[5] D. Posterski and R. Bibby, Canada's Youth Ready for Today (Ottawa: The Canadian Youth Foundation, 1988), p. 38.

[6] Posterski and Bibby, Canada's Youth, p. 28.

[7] Alberta Education Annual Reports (1989 and 1990).

[8] Alberta Education Annual Reports (1989 and 1990).

[9] Alberta Education Annual Reports (1989 and 1990).

[10] Alberta Education Annual Reports (1989 and 1990).

[11] Alberta Education Annual Reports (1989 and 1990).

[12] Alberta Education Annual Reports (1989 and 1990).

[13] Teruhisa Horio, Educational Thought and Ideology in Modern Japan: State Authority and Intellectual Freedom, ed. and trans. Stephen Platzer (Tokyo: University of Japan Press, 1989), p. xi.

[14] Cynthia Hearn Dorfman, Japanese Education Today (Washington: U.S. Department of Education, 1987), p. 22.

[15] Victor N. Kobayashi, "Japan" in World Education Encyclopedia, Vol II, ed. G.T. Kurian (New York: Facts on File Publications, 1988), p. 705.

[16] W.O. Lee, "The Search for Excellence and Relevance in Education: Lessons from Japan's Fourth Educational Reform Proposals" in The British Journal of Educational Studies, Vol. XXXIX, No. 1 (February 1991) pp. 21-22.

Report 3:

Observations Along the Way

A paper prepared by Edward J. Pacholko, a resource management consultant and a 30-year veteran of the oil and gas industry.

I. The Problems

A. Recommended Readings

Alarms have been raised about Canada's education system in a number of recent reports. Although the Alberta education system is one of the strongest in Canada, these alarms have direct relevance for the province.

Learning for the Future, a study of Canada's educational system produced by Corporate Higher Education Forum in 1990, offers the following insights:

- Although Canada's provincially decentralized education system expenditures are the fourth highest per capita in the world, our students' achievements on international tests are not good enough.
- Education reflects what society values. It follows that to improve education, we must first awaken the public and get its agreement that there is a need for change. What can we say about the priorities of a society where the average public school student spends 1,040 hours watching television per year, compared with 900 hours of formal instruction?
- The next century is likely to be characterized by rapid and dramatic change, and driven by technological advances, global interdependence and competition. In Canada, however, there are increasing shortages of skilled technical workers and an intrinsic disregard, even a disdain, for technical work generally.
- The responsibilities of teachers have expanded to include much more than the school curriculum. They are becoming increasingly involved with the social problems of their students and perform functions akin to parenting or to duties carried out by social service agencies.[1]

A 1990 report published by the Ontario Premiers Council, *People and Skills in a New Global Economy*, emphasizes the need for more advanced skills and knowledge in science and technology, and presents evidence of low student interest in these areas. It suggests the following:

- We cannot cling to low wage, low value-added activities where we have no competitive advantage. We must move into high value-added high wage goods and services wherein lie our best hopes for prosperity. By the year 2000, 50% of all jobs will need more than 17 years of education — this percentage is double the 1986 requirement.
- A survey of students' career interests showed that careers in skilled trades, science and technology were low on the totem pole of favor. The following chart ranks the careers of choice:
  1. Sports and Recreation
  2. Sales and Services
  3. Teaching
  4. Management and Administration
  5. Social Sciences and Community Services
  6. Law/Legal Profession
  7. Arts and Literature
  8. Medicine and Health Care
  9. Government Services
  10. Skilled Trades
  11. Science and Engineering
  12. Transportation
  13. Production Assembly and Manufacturing
  14. Fishing, Forestry and Mining
  15. Agriculture and Farming[2]

The 1987 *Ontario Study of the Relevance of Education and the Issue of Dropouts* by George Radwanski strikes hard at a person-centred philosophy and recommends that the emphasis of education philosophy should be shifted from process to outcome. The objectives of education should be defined in terms of the acquisition of specified, demonstrable knowledge and skills by all children.

The study's author notes that the school system is doing a poor job of education: "...only a little more than half of our young people, those in the advanced high school programs, are capable of benefiting from a genuine full-

"What can we say about the priorities of a society where the average public school student spends 1,040 hours watching television per year, compared with 900 hours of formal instruction?"
Corporate Higher Education Forum

scale education. For the rest, we have concocted a kind of education placebo, two lower levels of diluted content, unclear purpose and inadequate outcomes."[3]

II. Alberta Statistics

A summary of relevant statistics for the Alberta educational scene is provided in the 1989 ***Education in Alberta, Facts and Figures***.[4] Analysis of the report produces a number of important observations:

- The number of families with children at home has dropped to 67%, and this number is decreasing. ***That means there will be progressively fewer parents supporting and involved in education over time and in the face of the ever-increasing importance of education.***
- The proportion of school-age youths has dropped from 42% to 31% of the population in the last 25 years, and is estimated to drop to 23% in the next 25 years. ***That means there will be progressively fewer students in school, although skilled workforce needs in the province will increase.***
- Approximately 50% of Albertans have moved in the past five years. ***The increasing mobility of Albertans requires consistent delivery of core curriculum within the province as well as interprovincially.***
- The Alberta female adolescent (ages 12 to 19) pregnancy rate is 37% higher than the national average. Eighteen per cent of all births in Alberta are out of wedlock, and those numbers are increasing. One-parent families have doubled to 12% in the past 25 years.The Alberta suicide rate, while decreasing, is still one of the highest in the country. ***Changes in family structure and personal crises will continue to place additional burdens on the school.***
- The number of students (477,000) and the number of teachers (27,000) total 504,000, and represent one-fifth of Albertans. School board expenditures totalled $2.3 billion in 1989/90.
- Alberta's per-pupil expenditure at $4,946 (1988/89, K-12) ranks fourth-highest in Canada. ***Education is a people-intensive enterprise: how effectively money is spent is an issue.***
- The average age of teachers is now near 40 and is increasing. In the next ten years, about 25% of today's teachers will retire. ***There is a need for a strategy to replace a large number of retiring teachers.***
- Nearly 100% of Alberta teachers now have a university degree, and 12% have a post-graduate degree. ***That means the goal to have nearly all teachers in possession of a university degree has been attained.***
- The average participation rate of 17-year-olds in formal education is 66% in Alberta versus 94% in Japan, 89% in Germany, 87% in the U.S.A., and 72% in Canada. ***Alberta's low participation rate is a matter of serious concern in light of increasing educational requirements.***
- Some 45% of grade 12 students in Alberta public and separate schools do not graduate in their year. ***This high non-graduating rate is disturbing and may lead to high personal and public cost.***
- Of those receiving Grade 12 diplomas, 48% were advanced or advanced with excellence (increasing), 38% were general (decreasing), and 12% were a high-school equivalent. ***This means that of the students graduating from Grade 12, there is a substantial and increasing interest in an advanced diploma.***
- Statistics suggest that of all 17-year-olds in Alberta, approximately 34% do not participate in formal education, 22% participate but do not graduate in their year, and 44% graduate from high school. ***This means over 50% of students may be getting less than an adequate education.***
- Of all 17-year-olds, 25% go on directly to post-secondary school, of which 12% attend an Alberta university, and 10% go to college or a technical institute. ***This suggests that at least 25% of all***

Alberta students are receiving a relatively good education.

III. The Concern for the Non-Post-Secondary Two-Thirds

Canada and Alberta have about the highest participation rate in post-secondary education in the world.[5] On the other hand, Canada has a very low participation rate in formal education among 17-year-olds, and Alberta rates well below the national average.

About one-third of students graduate from Grade 12 and continue to post-secondary education. Approximately one-third obtain a Grade 12 diploma (some a marginal diploma), and enter the work force. Another one-third drop out of high school altogether to work, to join the unemployed or unemployable. Eventually, a number of these people do return to school, but this two-thirds of our student population is a source of major concern.

This concern has led the Corporate Higher Education Forum to state: "There is little focus in Canada on exactly what the two-thirds of students who are not going to post-secondary education are supposed to be achieving in school. Many young people, particularly dropouts, are leaving school without skills, aspirations, or prospects."

This concern was reinforced in the Alberta Chamber of Resources 1990 study, *Alberta Resource Development in the 1990s: A Response to Potential Skill Shortages.*[6] The report noted that the average age of Albertans entering into apprenticeship positions is 27. In comparison to other countries where a skilled trade is viewed as an exciting and rewarding career, Canadian students are not encouraged to seek career opportunities in the skilled trades area.

One of the most striking differences between Canada and the comparison countries of this study is the large amount of attention paid by other countries to transitions from secondary student life to post-secondary education or work life.

The highest leverage for Alberta and Canada lies in improving the state of education for the indicated two-thirds. At the same time, there are indications that there is under-investment and inequalities in learning opportunities for those who do not proceed to post-secondary education.

This study did not examine in detail the educational opportunities available to the vocational and general streams in the comparison countries, nor did it look at the mechanisms of ensuring transitions to work life from secondary school. Business is known to participate actively in those countries in facilitating effective transition.

It appears that the most pressing concern in Alberta is for the quality of education available to the two-thirds of students who are not proceeding to post-secondary education. It is recommended that the educational systems of the comparison countries be examined in more detail to learn how to achieve more effective high school-to-work life transitions.

IV. International Comparisons: The Lessons

A. Value Systems

Earlier in this study, two alternative future scenarios were identified: the second-phase industrial education option, and the person-centred education option.

It seems clear that the educational systems of the comparison countries (Japan, Germany and Hungary) are quite strongly rooted in the second-phase industrial values and have public support, although Patterson points out that there is now some re-examination of values in those countries and attempts made in Japan

"Albertans should be aware of the value choices in *their* education system. The education system should examine whether it adequately reflects the fundamental values of the population it serves."

"Education should be child-centred, in the sense of recognizing that the development of each individual child, each with his or her own predispositions, strengths and weaknesses, interests and learning styles — is the whole object of the exercise."
George Radwanski

to encourage more creativity.

A key question for Albertans is: does the education system in this province reflect the dominant value system of Albertans?

The answer is most probably no. To quote Mark Holmes in his 1991 essay, "The Future of the Public Schools in Canada": "Unfortunately, a dominant element of educators' beliefs lies on the fringe or outside the public consensus. The core elements of public belief (clear standards of achievement and behaviour, heavy emphasis on academic fundamentals, relevance of secondary programs to students' lives after graduation) — are widely opposed by influential educators (who prefer child-centred ideas, informal evaluation, and programs based on process rather than outcomes).

"More important to them (the educators) are the experiences to which children are exposed. Instead of formally learning skills and disciplines of knowledge, children should explore, discover, experience and choose."[7]

Holmes noted that in a 1985 poll in British Columbia, dramatic differences between public opinion and the opinions of professional educators were evident. With respect to standardized methods of student evaluation, 94% of the public considered standardized evaluations important (69% very important). Comparable figures for the educators were 15% important (3% very important)! Ninety-four per cent of the public considered standardized teaching materials very important, but only 20% of educators.

It seems fundamental that the education system should reflect the desires of the population it serves. In the comparison countries, that seems to be more nearly the case.

Radwanski offers a summary statement that is helpful: "Education *should* be child-centered, in the sense of recognizing that the development of each individual child, each with his or her own predispositions, strengths and weaknesses, interests and learning styles — is the whole object of the exercise.

"But it should at the same time be *content-oriented*, in the sense of recognizing that the whole object of the exercise is to develop each individual child by bringing him or her into possession of the specific knowledge and skills that every young adult coming into our society should have."

Albertans should be aware of the value choices in their education system. The education system should examine whether it adequately reflects the fundamental values of the population it serves.

B. Support for a Work Ethic

There are some important differences amongst the comparison countries' societal beliefs concerning hard work and effort.

In Japan, there is a strong belief that the main determinant of academic success is student effort. The North American parent and student are more likely to attribute success to innate ability.

The student attitude toward achievement also differs. In Japanese schools, the norm is high achievement. In North American schools, it seems that achievement is de-emphasized.

Stevenson reports from a comparative psychological study that high achievers in the U.S. experienced stress because the norm is against achievement. In Japan, however, low achievers felt more stress (the same study reveals that the commonly-held belief that there are high psychological costs to high achievement among Japanese students is a myth).[8]

Japan has many structures in its system that support the notion that hard work is important. These include a high reliance on achievement tests and entrance exams, attention to post-secondary transitions, strong adult influence, and social norms. Opting out of

education is not an acceptable option, and remedial work is encouraged.

The European systems also have structures that support the work ethic. In Germany, students not enrolled in full-time schools are required to attend part-time vocational schools until the age of 18. As a result, Germany appears to excel in the area of vocational education with some 57% of its students between age 15 and 19 enrolled in part-time vocational schools, and another 23% in full-time vocational schools. These part-time vocational programs are complementary to apprenticeship programs in some 500 vocations. Business is intimately involved in this part of education.

From an Alberta industry perspective, it is clear that a strong work ethic is a desirable attribute in students coming from the education system.

Alberta's education system needs to ensure there are sufficient structures and mechanisms in place to demonstrate to the student that hard work is important, that remedial work rather than opting out is ultimately rewarded. Business needs to play a much stronger role in working with educators in this regard.

C. Part-Time Work

A comparison of education systems reveals that part-time work undertaken by high school students is becoming an increasing distraction and detriment to learning in schools throughout North America.

Again, some important societal differences emerge. In Japan, only about 20% of high school students work. In Alberta, 50% of students aged 15 to 19 work part-time or full-time. Japanese students do not drive until age 18, and only 20% 'date' in high school, thus further reducing distractions.

Germany requires that students continue with formal education while working to age 18. Work experience for these students is most often geared to a vocation.

Business should recognize that the encouragement of part-time work may be self-serving and not in the best interests of students, especially those demonstrating low academic achievement.

The level of part-time work among high school students may be detracting from academic performance and contributing to an early drop-out rate with consequent personal and societal cost. This is a subject for further research and public dialogue. More information and dialogue is required before effective strategies can be developed.

D. Streaming Philosophies

The Japanese do not believe in early streaming and advance all students together without differentiation until grade 10. Only then, they say, can streaming begin because only then through demonstrated effort is a student's capability known.

The German system is often cited for its tendency towards early streaming with the student's destiny in life determined by the end of grade six. There is some increasing flexibility to transfer from stream to stream upon demonstrated ability and through the establishment of comprehensive schools in the middle grades. The early streaming system is under attack because it is perceived to result in inequality of education opportunity.

Like Japan, Alberta does not stream its students until grade 10. This principle is well accepted in a province where egalitarian principles are in high regard.

The streaming philosophy is not a critical issue in Alberta.

E. Parental Role

A student's academic performance is affected by experiences at home as well as those at school.

There are cultural differences among countries and differences in parental involvement. In a 1990 comparative student of parent involvement between U.S. and Asian

"In Alberta, there seems to be a deterioration of the parenting role with less time and interest being given to educational achievement. It is not surprising therefore that student motivation is inferior to that in Asian schools."

"Alberta has taken concrete steps toward standardized testing, but not to the demanding extent of the comparison countries."

schools, *Contexts of Achievement*, Harold W. Stevenson and Shin-ying Lee concluded there are clear parental involvement factors which result in poorer performance in American schools. These include:

- insufficient time and emphasis on academic achievement
- children's achievement is not a widely-shared group goal
- parents overestimate the child's accomplishments
- parental standards for achievement are low
- there is little direct involvement of parents in children's schoolwork
- there is an emphasis on innate ability that undermines the belief that children should be able to master the curriculum.

A practical finding was that in spite of smaller homes, over 80% of Japanese parents allocated their child a quiet place to study. Of fifth grade students, 95% had their own study desk versus 63% in the U.S. Japanese fifth grade children were found to watch even more television than their American counterparts but at a time separate from homework.

In Alberta, there seems to be a deterioration of the parenting role with less time and interest being given to educational achievement. It is not surprising therefore that student motivation is inferior to that in Asian schools.

A corollary of delegating to schools the responsibility for academic achievement is that parents are realistically informed about the education system, school performance, and the performance of their children. Educators are in control of this information. Mechanisms, perhaps similar to corporate audits should be installed to ensure that the public is provided realistic and unbiased information.

The importance of parenting to academic achievement deserves publicity and parenting programs need encouragement. Educators need more support from parents in the process of education and need to provide realistic information to parents.

F. Spiral Curriculum and Repetition

The dominant structure for curriculum design in North America seems to be the spiral curriculum whereby for example it is believed that mathematics can be taught effectively by gradually increasing the exposure of students to a variety of ideas accompanied by an annual review.

Teacher-Assigned Marks and Diploma Examinations: June 1991

	Diploma Exam Failed	*Teacher Failed*	*Blended Failed*
Math 30	34.5	9.1	11.3
Biology 30	21.8	11.6	8.6
Chemistry 30	22.2	11.8	8.3
Physics 30	21.3	8.9	5.1
English 30	9.5	4.0	7.1
Social 30	17.6	8.1	6.3

There is much revising of concepts already introduced, supposedly at a higher cognitive level at each revisitation.

The presence of the spiral curriculum certainly appears present in Alberta grade seven, eight and nine mathematics course, and combined with an unfortunate selection of textbooks, has led to wholesale repetition.

This repetition not only wastes time, but it undermines teacher accountability for teaching a particular concept to the point of mastery. It leads to boredom on the part of the student. As well, it may discourage students from trying to accomplish a task correctly the first time since repetition is anticipated as normal (note the increasing number of grade 12 repeats).

Repetition in curriculum is undesirable. The Alberta grades seven, eight and nine textbook selection needs immediate attention to eliminate the very high degree of repetition.

G. Direct Instruction

The direct instruction method is one that teaches, tests and reviews those things that one wants learned in a cumulative sequence. Concept mastery is obtained at the time of teaching and there is much less revisiting of concepts. This is the method used successfully in Japan.

According to Professor Mark Holmes in his 1990 essay "The Future of the Public Schools in Canada": "...there is now virtually irrefutable evidence that the most effective method of teaching new concepts, skills and knowledge is by direct instruction." As a result of recent large-scale empirical research, "...carefully structured systematic direct instruction sequentially organized topic by topic is the method used by the world's most effective education systems."

Holmes notes that instruction methodology should not be imposed on teachers for the practical reason that it is difficult to impose an alien teaching style where the culture is antagonistic to it. Teachers should be encouraged to develop their own style, but be held accountable for children's learning outcomes.

Piloting in mathematics instruction is occurring in Alberta (at the Fort McMurray Catholic school board) with a form of direct instruction methodology based in the principles of parental involvement, clear understanding of desired outcomes in each grade K-12, clear standards and teacher accountability, high expectations and hard work, and mastery by all students of concepts along the way confirmed by testing. The emphasis is on mastery of content *by all students*, not just coverage of content and mastery by some.

Already, although it is in the very first stage of implementation, the pilot is showing positive achievement results — and in the face of the deeply-entrenched spiral curriculum.

The pilot methodology is strikingly similar to that used so successfully in Japan and other countries. It negates the idea that we cannot utilize to our advantage methods from other cultures because of insurmountable societal differences.

Pilot trials in direct instruction with a focus on outcomes in math as well as the sciences, reading, and writing should be encouraged.

H. Achievement Testing

In this study's comparison countries, challenging achievement tests are considered standard practice. These achievement tests include exams not only in math and the sciences but also in the humanities. Tests are usually written or essay type, and may have oral and demonstration components.[9]

The U.S. is now establishing goals for national testing and the Canadian government has just issued a discussion paper promoting national testing and standards.

Under the auspices of the Council of Ministers of Education, Canada, a national test for mathematics, reading

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Stevenson and Lee

and writing is being designed that will permit interprovincial achievement comparisons and by implication should lead to national standards.

It is noted that entrance exams are required for entrance to high school in Japan. University entrance exams are also required. Thus, there are two significant events emphasizing achievements required of a student desiring to take post-secondary education.

In the European countries, national tests are a certificate of achievement that leads to further study and station in life. The tests serve to establish national standards about what must be learned in school, and reinforce the notion that hard work counts.

In Germany's decentralized system, the secondary leaving-school certificate is based on national guidelines. There are both written and oral tests, and the results provide the basis for post-secondary admission.

Hungary requires both high-school diploma and university entrance exams.

In France, 50% of all students now take the demanding baccalaureate exam. A goal of 80% participation has been established for the year 2000.

To further demonstrate what is possible: the 12 members of the European community have established European schools in several community countries, and have developed a European baccalaureate examination upon which a diploma, valid in any of the member countries, is granted.

Alberta has taken concrete steps toward standardized testing, but not to the demanding extent of the comparison countries. Alberta grade 12 students are required to write at least one diploma examination in either English 30 or English 33 to receive a high school diploma. Other exams are offered in Social Studies 30, Math 30, Biology 30, Chemistry 30 and Physics 30, leading to an advanced diploma.

The final mark in those subjects is a blend of 50% based on diploma exams, and 50% based on teacher-assigned marks. The June 1991 results show a dramatic divergence between teacher-assigned marks and the diploma examinations.

The striking divergence between diploma exam marks and teacher-assigned marks has led to controversy. Unfortunately, some critics have suggested that diploma exams are unfair to students and should be abandoned. Some 20% of students were able to perform very well in Math 30, indicating that perhaps that test has some validity as a measure of competency.

Alberta has taken other positive steps toward achievement monitoring: since 1983, Alberta Education has administered periodic achievement tests in Social Studies, Language Arts and Mathematics in grades three, six and nine. In addition, Alberta is now participating directly in international achievement comparisons.

These achievement tests are admittedly not without flaws or controversy. However, properly anchored to standards, they should allow performance rating according to agreed-upon criteria of competence, permit objective comparisons, and assess the degree of mastery of the curricula.

Other countries demand the mastery of a core curriculum and design tests to demonstrate achievement. Neither of these aspects has been emphasized in the Alberta system.

1. Length of School Year

Much has been said about apparent differences in the length of the school year. Japan, for example, has an average school attendance of 243 days compared with the North American average of 186 days.[10]

The average of 19 other countries, excluding Japan, is 191 days. The longer school year in Japan is accounted for in part by time spent on school excursions, national festivals, and the like. Analysis of international data shows no apparent correlation

between school year length and math achievement.

Stevenson and Lee point out that the Japanese classes are 50 minutes long followed by a (wild) 10-minute recess. His work shows that actual class time is nearly comparable to the North American standard.

The significant difference is that class time is better utilized in Asian schools.

J. Efficient Use of Class Time

Stigler and Stevenson have found through extensive classroom observation studies that class time is used significantly more efficiently in Asian schools as compared to American schools.[11]

Asian students spend about one-third more time engaged in learning in a typical class period than American students in a typical class period. Stevenson reports for example that grade five students attend to task more than 80% of time in typical Asian schools (Japan, Taiwan and China) compared to about 55% of time in comparison U.S. schools.

Time in U.S. schools is wasted through disruptions, discipline problems, off-topic discussions, and unsupervised desk work.

Stigler and Stevenson observe that the longer time on task was filled with high-quality experiences. Moreover, no doubt as a result of more efficient class time use, teaching patterns and lesson connectiveness were much superior in Asian schools.

This efficient and effective use of class time may well be the most important factor impacting performance of North American versus Asian schools. Although there have been no studies within the past ten years to confirm it, Alberta schools appear to suffer from a significant waste of class time.

It is strongly recommended that Stevenson's or like methodology be applied in Alberta to accurately describe the efficiency of class time use.

K. School Discipline

School discipline is repeatedly cited as an increasing and uncontrolled problem. Even more disconcerting is the fact that discipline problems are becoming more prevalent at earlier grade levels, and these incidents are occasionally accompanied by violence.

Discipline appears to be much less of an issue in Japanese and European schools, and in Canadian private schools. Further, discipline problems are strongly linked to the issues of efficient class time use.

A 1976 University of Alberta study, the *General Report of the Alberta School Discipline Study*, indicates that "there was considerable satisfaction with school discipline as it was in 1975/76" and "the direction of change would be to slightly stricter school discipline."[12]

That study was based on analysis of questionnaire responses from educators, parents and students; it included no direct independent classroom observation. Discipline in the classroom seems to have deteriorated significantly since that study was written.

It is recommended that the degree, distribution and nature of classroom discipline problems be investigated in Alberta through direct independent classroom observation.

L. Teacher Preparation

Almost 100% of Alberta teachers have university degrees. However, only one of five teachers in the province major in mathematics or science (approximately the same number that major in physical education; the remainder major in social and liberal studies.)

With the declining interest in mathematics and sciences, and the looming need to replace 25% of today's teachers in the next ten years, where are the math and science

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teachers going to come from?

Recently, Alberta has embarked on science curriculum changes in senior high school. It will expose and hopefully attract more students to the sciences, but it is not clear that more science can be delivered, or that the rigor of science programs will be increased for those students who wish to pursue careers in science and technology.

Practitioners believe that many if not most elementary teachers in Alberta do not have university courses in the mathematics or sciences. In the junior and senior high schools of this province, the trend is toward better qualifications although many teachers are believed to teach outside of their discipline.

In Alberta, the province's three faculties of Education have accountability for teacher preparation. Some critics have suggested that the first priority should be the attainment of skills in specific disciplines, followed by one or two years of preparation in classroom effectiveness. Additionally, it is felt that mathematics and sciences instruction in the schools is not relevant to the real world, and math in particular is considered 'abstract' by students.

There are a number of initiatives to address this, but what better way than to attract teachers with qualifications in math/science combined with industry experience?

In Japan, most new teachers have a four-year college degree, with about two-thirds having majored in fields other than education. The proportion of those hired who are not graduates of colleges of education increase with the school level: they fill one-third at the elementary level, two-thirds at the junior high school level, and nearly 90% at the senior high school level.

In the comparison countries, teaching is a highly respected profession and attracts many of the populations' finest students. In Japan, teaching confers high social status and economic reward. The beginning salary of a high school teacher in 1984 in Japan was 15% higher than the average salary of an employee with an equivalent degree in a private company. Commensurate with their status, teachers are exposed to constant public scrutiny, and are hired on the basis of credentials, written and skill-testing tests and interviews.

From elementary school onward, Japanese mathematics teachers are reported to be very well qualified as a result of good training, in-service programs, and collaborative lesson preparation. Most have the ability to leave lasting impressions regarding the math concepts they teach.

Strategies are required in Alberta to address the quantity and qualifications of mathematics and science teachers at all levels. These could include intensive in-service programs, remuneration incentives for math and science specialists, and the attraction of professionals from other fields into teaching. Strategies to attract bright and well-qualified persons to teaching and keeping them in the profession are needed.

Some recent initiatives at the University of Alberta should be helpful: a two-degree Science/ Education route and extension of industry co-op programs to Science/Education majors.

The Alberta public is prone to blame teachers for any shortcomings in education, but the accusation is unfair. Stigler and Stevenson's comments are noteworthy: "We cannot blame teachers when we deprive them of adequate training and yet expect that on their own they will become innovative teachers: when we cast them in the role of surrogate parents, counsellors and psychotherapists and still expect them to be effective teachers; when we keep them so busy in the classroom that they have little time for professional development once they have joined the ranks of the teaching profession."

Alberta must develop a strategy to address shortages in

qualified mathematics and sciences teachers. Alberta should also re-examine its mathematics and sciences teacher preparation practices including in-service programs and apprenticeship of new teachers.

M. Classroom Organization

The class sizes in Asian schools are large by Alberta standards, with typically 35 to 40 students compared to approximately 25 in Alberta classrooms — yet teaching in the Asian schools is effective.

A noteworthy difference between the two systems is that Asian teachers teach in front of a class for only three to four hours a day. The remainder of time is spent primarily on class preparation which is done collaboratively with other teachers and student-related administration.

Japanese teachers are typically well-prepared and organized to undertake intensive periods of classroom activity with a relatively large group of students. At the same time, because classes are 50 minutes long with 10-minute breaks, students are ready for intense work.

The feature of collaborative preparation is lacking in the North American system, perhaps due to a lack of time as teachers teach smaller classes for more hours of the day. The need for collaborative preparation and improved apprenticeship is most vital for new teachers in the system.

Alberta would do well to consider alternative classroom structures that could lead to more effective teacher lesson preparation and delivery. Improved apprenticeship mentoring of new teachers and teacher collaboration in lesson preparation are vital.

V. Solutions

A. Education in Canada: A National Perspective

The provinces in this country have constitutional responsibility for education. The federal government also has a role and invests $11 billion annually into the learning system (post-secondary support: 65%, adult training: 20%).

Canada, with its 12 jurisdictions, has an enormous amount of governance in education: it has an immense amount of duplication of effort in policy development, curriculum design, text selection, standards setting and administration.

These jurisdictions are relatively small. With its 2.5 million population, Alberta is the size of a medium-sized city in today's world scale.

Curricula amongst provincial jurisdictions is inconsistent and uncoordinated. In 1982, the Second International Science Achievement Study attempted to determine what is taught in sciences in this country, and demonstrated a low level of consensus on what concepts should be delivered and at what point within the curricula.

This fragmentation of education effort in Canada is conspicuously absent in the comparison countries. The national education systems of Japan and Hungary — and in fact of most developed countries — look appealing by contrast.

Germany is decentralized into state jurisdictions, but the states are large, national standards of achievement testing exist, and the federal government has certain specific authority in education planning at all levels.

Canadian education's fragmented nature is sometimes defended by the need for different content for different cultural regions of the country. However, it is difficult to justify differences in core curricula in mathematics, physics and chemistry among provinces and territories.

There is an effort by the Council of Ministers of Education, Canada to address commonality of standards through establishing national tests. The federal government is also considering its role in establishing national priorities and goals for education. Most nations have initiated national curriculum guidelines, assessment processes and national

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"Alberta should support initiatives that develop a national perspective on education."

certification systems long ago.

Alberta should support initiatives that develop a national perspective on education.

B. Money and Education

Alberta is the fourth-highest spender per student on education in Canada, and one of the highest spenders in the world. Expenditures in Alberta education have quadrupled since 1975 while student enrollment has remained static.

An analysis of 187 studies by Hanusek[13], spanning two decades of research, provides strong and consistent evidence that the level of expenditure is not directly related to student achievement. Expenditures are generally a function of teacher education, teacher service, the teacher-to-pupil ratio, administrative and facility costs, but more expenditures in these areas do not necessarily correlate with improved achievement.

This is not to say that teachers and schools do not count. Teachers and schools vary dramatically in their individual effectiveness.

Neither is it to say that money could not count. The fact is that money does not consistently "count" within the current organization of schools. For example, increasing teachers' remuneration should expand and improve the pool of teachers. Improvement in the quality of teaching skills would depend on whether or not school systems recruited and retained the best teachers from the pool.

This point raises the age-old issue of merit pay for performance. For the most part, industry compensates its professionals on the basis of merit and finds it difficult to understand why the teaching profession is not similarly treated.

The research raises a number of questions: what causes the apparent waste of resources, why is there not more pressure for efficient operation of schools, what incentives would improve school effectiveness, and can the institutional structure be altered to improve effectiveness?

The lesson that industry has had to learn in an increasingly competitive world is that improved quality, reliability and productivity can be obtained in the face of real cost reductions.

An international lesson in education follows: "Besides extracting the most learning time from the time available, education needs to ensure that its other resources are deployed in accordance with its priorities. The Japanese have put their money into a high quality teaching force and basic education materials, not into frills, large bureaucracies, lavish facilities, innumerable electives or platoons of specialists — yet the children learn while in school to play musical instruments, to read a second language — in most schools, even to swim."[14]

The policy implications suggest that the solution to educational problems is not more money, but rather changes within the current institutional framework that result in improvements in how the available financial resources are spent, and a clear focus on academic achievement in the schools as a top priority.

C. Partnerships and Initiatives

It is a conclusion of this study that partnerships between educators and business, parents and the public are indeed useful if only to promote communication and understanding.

These partnerships have led to a number of education improvement initiatives. The literature and media are replete with examples.

Internationally, the concept of business/education partnerships has been well-established. In Germany, it is reported that there are 500,000 partnerships, many of them effectively involved in school-to-work transitions[15]. Similarly, in Japan there is close communication and a client relationship between schools and industry. Many high schools actually operate a student placement service and, moreover, ongoing counselling and guidance

after the student has graduated.

In the U.S., business/education partnerships are a recent phenomenon[16] and rose from 40,000 to 140,000 partnerships between 1983 and 1988. While many of these are effective, by self-admission, 55% of business initiatives report little or no difference in educational outcome[17]. Success for such partnerships requires a clear mission with common, well-understood goals and priorities.

In Canada, the concept of business/education partnerships is still relatively new but growing in momentum. There have been numerous initiatives in the mathematics and sciences areas over a long period of time, but without clear signs of any improvement in the output of the educational system.

In Report Two of this study, the author suggests that a centre for mathematical and scientific instruction should be established as a partnership between educators and education stakeholders, parents and students, business, government, post-secondary institutions and others. This suggestion is worthy of consideration because it is a means of coordinating and priorizing scarce resources and could bring about effective action to improve the educational system. A substantial portion of this centre's energies would be expended towards producing tangible tools and resources that would be accepted and used in the classroom to improve science and mathematics instruction.

Partnerships serve to improve communication and understanding; they can also be used effectively to improve school-to-work transitions. However, they must be well formulated to be successful.

D. Education Reform: A Scenario for Change

In October 1991, the Alberta Minister of Education, the Honorable Jim Dinning, issued a milestone document entitled "Vision for the nineties...a plan of action."

The document begins by noting that Alberta is experiencing fundamental changes in its economic, social and cultural fabrics. The emergence of a highly competitive and integrated global economy, rapid technological innovation, and an expanding knowledge base will continue to have profound impacts on all our lives. The document links the global realities to the necessity of ensuring the ongoing improvement of Alberta's education system in ways which make the best possible use of available resources, and describes the immediate need to take a quantum leap forward.

There is much in the vision document that the observations and findings of this study strongly support. The vision for Alberta education is described as excellence for all Alberta students with a focus on goals, results and accountability.

The document goes on to describe action initiatives in a number of key areas and the expected results. Priorities for the next two or three years are identified:

- Achieving superior standards and results
- Enhancing the curriculum
- Building strong basic skills
- Encouraging students to stay in school
- Doing what's best for disabled students
- Building a strong future in science
- Enhancing teaching
- Improving equity of opportunity for students
- Enhancing partnerships

The achievement of the action plan's objectives will require the energy and commitment of education stakeholders. Significantly, a public dialogue has been initiated around the vision document to actively engage the stakeholders in education reform.

The identified action items and priorities should find ready acceptance with the business community. The most pressing concern identified in this study is the

"Success for (business/education) partnerships requires a clear mission with common, well-understood goals and priorities."

"A vision of the ideal for education is beginning to take shape in Alberta..."

quality of education delivered to the non-post-secondary two-thirds of students, many of whom either drop out of formal education or receive a less than adequate preparation to enter the workplace, coupled with a declining interest in skilled trades and technical careers and poor school-to-work transitions. The Minister's stated focus should contribute substantially to alleviating the most pressing concerns.

E. Outstanding Questions

There remains an uneasiness however that the attempts at education improvement and reform will not be substantial or deep enough. The stated plan intends to build on the strengths of Alberta's education system, but will the reform attempt prove to be superficial? Will the root causes of education problems be identified and will underlying system changes be made?

Other education reform attempts in North America are sobering to contemplate. An example is the large-scale effort conducted at a policy level involving Louisiana stakeholders. Over a ten-year period, initiatives by the Louisiana Association of Business and Industry, as well as other organizations, have led to more than 50 major reform laws and policies.

However, most of these reforms have been watered down, ignored, implemented improperly, taken to court, mired in turf battles or not funded, and education-quality indicators remain low[18, 19]. In fact, the Association has recently published a report titled "Ten Years of Education Reform in Louisiana: A Long Journey to Nowhere."

An unadulterated business approach to education reform would no doubt propose the following:

- Establish clear goals in the system
- Hold players accountable for output
- Measure and audit performance and outcomes vs. inputs
- Pay for performance
- Keep records of inputs and outputs
- INTRODUCE COMPETITION

In short, business would propose to run education like a business.

Indeed, many of the current calls for improvement in the education system are grounded in the concepts of goals, accountability, measurable outcomes and performance. 'Competition' would translate here as the factor of choice among competing schools for students and parents. This concept of choice in education is gaining momentum. Currently, there are a number of advocates of choice in schooling, and numerous pilot projects and experiments underway in other jurisdictions.

F. Other Jurisdictions

In Britain, recent reforms have introduced a system whereby schools are funded according to enrollment figures and are allowed self-governance within a prescribed national curriculum. A bill to require schools to publish examination results is also under consideration.

Canada already has some effective schools that provide desirable outcomes: academic achievement, curiosity and creativity in the child, enthusiasm, work ethic, and manners. These are often the results of our private schools, but the same outcomes have been effected in some of North America's worst socio-economic ghettos[20, 21].

The solution may well be a system that creates private school characteristics in a public school system — with a high level of egalitarian values maintained. School self-governance, excellent principals, meritocracy with teachers, family choice, clear expectations, classroom effectiveness, and high curriculum and achievement standards are a few of the lessons private schools might pass on to their public counterparts.

G. Effective Schools

Effective schools models incorporating the above

effectiveness tactics could well be piloted in Alberta, particularly in the province's disadvantaged areas. A practical difficulty with such education reform exists in the smaller centres where choice is limited; however, the performance of these schools should improve by following the example of effective urban and disadvantaged area schools. Additionally, the exercise of choice implies an enlightened public.

A vision of the ideal for education is beginning to take shape in Alberta, but it may be necessary to redesign the system to deliver this ideal. Effective schools can be a model for change.

The effective school models and pilots in North American and elsewhere deserve policy maker, public and educator interest. Dramatic system change may be the ultimate solution to effective schooling in Alberta.

H. Recommendations

The following recommendations flow from the 'observations along the way.' Although they are directed to specific groups or sectors for primary attention, education is in fact the business of all stakeholders; collaborative effort is essential if substantial improvements are to take place.

Recommendations for Stakeholder Partnerships:

1. Focus more attention and publicity on the quality of education received by the two-thirds of students who do not proceed to post-secondary education.

2. Learn from successful models in other countries by examining in depth the structures and the mechanisms that provide effective transitions from secondary schooling to work-life.

3. Promote interest in science and technology careers and the skilled trades among students.

4. Create an information campaign designed to promote awareness of the linkage between education and economic prosperity, to promote endorsement of work ethic values, and to publicize and debate the value choices and their consequences for Albertans.

5. Support the early installation of the new Alberta science 10/20/30 curriculum which has the promise of providing more science to more students and attracting more students to science careers.

6. Support the early establishment of a Centre of Mathematic and Science Instruction with members including professional educators, business, government and the public. The Centre would be a focus for math/science instruction innovation, and a monitoring and a co-ordinating group for the advancement of math/science education in the province.

7. Examine the incidence of part-time work and develop strategies to reduce any detrimental effect such work has on academic achievement.

8. Publicize the importance of parenting programs to academic achievement. Encourage and support parenting programs.

Recommendations for Business:

1. Play a much more active and effective role in improving school-to-work transitions and participate in learning how to do so from other countries.

2. Publicize the linkage and the role of science, technology and skilled trades with national and individual economic prosperity.

3. Communicate more clearly its expectations of the education product for the current and evolving job markets.

4. Undertake to play an active role in stakeholder partnerships at all levels from the policy level to the local school level.

5. Encourage and support the participation of employees on local school boards.

Recommendations for Educators:

1. Ensure that Alberta's education system contains sufficient structures and mechanisms in place to demonstrate to the student that hard work is important. Strengthen and maintain structures supporting outcomes and mastery of core curriculum such as achievement tests and standards.

2. Take immediate steps to determine and understand the effectiveness of use of class time and the degree, nature and distribution of discipline problems through independent direct classroom observation. Compare the results with effective schools and with effective systems in the world with a view to developing strategies to address classroom time effectiveness.

3. Experiment with the size and organization of Alberta classes to allow more time for more collaborative lesson preparation by teachers.

4. Redesign the grade 7/8/9 mathematics textbooks to eliminate undue repetition and any other unproductive repetition in the math/ science curriculum.

5. Encourage direct instruction pilots in mathematics and consider for other subjects.

6. Reflect the ability of students to take more mathematics and science earlier in the curriculum and learn from the example of other countries. Examine test materials to understand what students of other countries actually master through earlier math/science.

7. Re-examine the textbook design and selection philosophies and the role of the textbook in instruction for cost and effectiveness, learning from international examples.

8. Strengthen and maintain the provision of realistic information to parents and the public about student and school achievement and outcomes.

Recommendations for Education Policy Makers

1. Establish academic achievement as a top priority.

2. Continue to vigorously pursue public debate and understanding of education issues and to provide leadership in implementing the priorities identified in the 'Vision for the nineties...a plan of action.'

3. Seek solutions to problems in education not through higher expenditures, but rather through efficiencies and, if needed, program scope reductions in lower priority areas.

4. Develop strategies to overcome current and future shortages of qualified math/science teachers including opening opportunities from science professionals in other fields.

5. Encourage more teacher apprenticeship and in-service program development.

6. Monitor and undertake to learn from effective school models and consider initiating effective school pilots in Alberta, particularly in disadvantaged areas.

7. Support national initiatives that develop a national perspective on education in terms of priorities, achievement indicators and national standards.

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